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THE SELECTION OF AN ELECTRICAL SYSTEM FOR STEAM RAILROAD OPERATION.

The English roads seem to favor the direct-current system, such as has been developed in trolley service. Italy has both direct-current and induction motor systems. Switzerland is planning an alternating-current distributing system with direct-current motors, transformation being effected on the locomotive. In this country the railroads seem to think that the direct-current system will be too expensive to install, and are content to go on as they are or to wait for the demonstration of a practical alternating-current system. In certain sections, however, where local conditions are peculiar, electrification is already in progress.

WATTMETERS AND AMMETERS.

In a report on lost and unaccounted-for current presented to the National Electric Light Association, Mr. L. G. Van Ness touched upon the shunt-current losses in integrating wattmeters. His figures show that this loss is much more than one would expect. While it is true the power absorbed in the wattmeter shunt is small, yet this loss goes on all the time, and amounts to from sixteen to thirty-six kilowatt-hours per year per consumer. Where every consumer has a meter it is evident that the loss to the station amounts to a very respectable figure, which might be avoided if, as Mr. Van Ness suggests, integrating ammeters were installed instead of integrating wattmeters.

Light Wanted; Electricity Paid for.

At first thought one would be rather inclined to object to this change, on the ground that the consumer should pay for what he uses, and not merely one factor of this. But what the consumer really wants is light, and not electrical energy, and he buys the latter merely because it is a convenient method of estimating how much light has been used.

Watts Consumed No Measure of Illumination.

It is well known that the watts consumed do not give an accurate measure of the light developed. The candle-power of an incandescent lamp varies by something like the fifth power of the voltage, and it is this variation which makes it necessary for the central station to maintain such careful regulation throughout its lighting district. Now, it is true that the integrating ammeter would not give as accurate a measure of the light produced as the wattmeter, because it would not be affected by variation in voltage. On the other hand, the lighting company is compelled by the demands for satisfactory service to maintain a fairly uniform potential, and it is probable that the readings of a good integrating ammeter would be satisfactory for all practical purposes. The advantage, however, would lie with the company, because, first, of the saving effected; and, second, if the service be poor, the watt-hours give a fairer way of estimating the actual light produced than do the ampere-hours, though it must be said that so far as measuring the illumination produced, neither way is more than a makeshift.

THE ADVANTAGES OF SUPERHEATED STEAM FOR TURBINES.

Advocates of the steam turbine have given as one of its advantages its ability to operate at high temperatures, and therefore superheated steam may be used to advantage. The great gain in the use of superheated steam with reciprocating engines is brought about by the prevention of cylinder condensation. When saturated steam is admitted to a steam cylinder it meets metal cooled by the expansion of the previous charge of steam. Condensation then takes place, and a certain amount of heat is passed to the walls of the cylinder. Some of this may be regained by reevaporation, but much of it is lost, and, in addition, water collects in the cylinder. If the steam be superheated, the walls of the cylinder may never become cool enough to cause condensation; but where highly heated steam comes in contact with rubbing parts, the high temperature makes lubrication difficult.

Condensation Avoided in Turbine.

In the steam turbine steam is admitted at one end of the machine and passes out at the other. There is no reciprocating change of temperature, and, due to conduction of heat, it is probable that the parts which come in contact with the steam are at a higher temperature than the steam itself. There should then be no trouble from condensation. Moreover, since the parts which come in contact with

the highly heated steam do not need lubrication, this difficulty is also removed. This condition has raised a question whether the use of superheated steam would actually be economical. Would the increased expansive force due to the higher temperature pay for the additional heat units required to raise the steam to that temperature?

Superheating Is Economical.

This problem has been studied experimentally by Herr Ernst Lewicki. The machine tested was a thirty-horse-power De Laval turbine, running at 20,000 revolutions per minute. The results show that a marked economy is brought about by the use of superheating. It was found that when operating at eighty-five pounds steam pressure the steam consumption with saturated steam, when developing 21.4 horse-power, was forty-seven pounds per horse-power-hour; and with steam superheated to 460 degrees centigrade, the consumption fell to 31.8 pounds per horse-power-hour. At full load, with an output of 41.1 horse-power, the steam consumption with saturated steam was 38.8 pounds per horse-power-hour; and with steam superheated to 500 degrees, the consumption was 23.5 pounds per horse-power-hour.

Less Friction with Superheated Steam.

Another interesting test was made to determine the frictional resistance to the turbine wheel, when revolving in air, in saturated steam and in superheated steam. The figures are as follows: In air, 4.6 horse-power was required to maintain the wheel at 20,000 revolutions per minute; in saturated steam, the power required was only 3.3 horse-power; and with 300 degrees superheat, only 1.88 horse-power was required.

A Loss Due to Superheating.

There is one loss which is increased by the use of superheated steam, due to the increased temperature of the exhaust steam. But the heat which would thus be carried away may be partially saved by using it to assist in superheating the saturated steam. The results of these tests are most gratifying, as they show that in addition to its other advantages, the performance of the steam turbine is decidedly improved by the use of superheated steam.

DISTRICT HEATING.

A topic which brought forth an interesting discussion at the recent National Electric Light Association convention was district heating. By "district heating" is meant the heating of buildings within the neighborhood of the power station. This may be carried out in several ways, either by exhaust steam, live steam or hot water. The idea of selling the heat carried off in the exhaust steam or in the condenser as a by-product is an attractive one, and the appointment of a committee in the past year to present a report on this subject from the station manager's standpoint was a wise move.

Report of Committee on District Heating.

The report of this committee was submitted at the recent convention, but, unfortunately, it had been found practically impossible to secure reliable information on the subject. Indeed, it would seem from the discussion started by the reading of this report that but few of those companies which are doing a heating business really know whether this business pays or not. Those companies supplying heat to the immediate neighborhood, and using for this purpose exhaust steam, seem to be the only ones which have found the heating business profitable. As soon as they begin distributing to districts lying further from the station, the cost of installation increases quickly, and it becomes doubtful whether or not the extension pays. At least, this was the impression gained by listening to the discussion on district heating.

What Is the Value of Exhaust Steam as a By-Product?

It is probable that this uncertainty has had much to do with the slow development of heating from power stations. Exhaust steam is a by-product of the power station. It has been found in so many industries that the best profit was made by utilizing what had been formerly thrown away. The idea of saving this is not a new one, and it has doubtless been considered by the managers of all the large lighting stations; so that it seems strange that as yet they have not been able to decide definitely upon the value of this business. The report on district heating states that there are in this country about one hundred heating plants of this character, and it would not be an expensive matter to carry out on several of these plants exhaustive tests, which would prove definitely the value of each particular installation, and from which sensible conclusions could be reached in reference to other installations. With this view in mind the committee on district heating was continued for another year. By the time the second report is presented it is to be hoped something definite will be known. The experience of the country last fall during the coal strike emphasized the need of better methods of heating in large cities, yet lighting and power stations are throwing away every day heat in a convenient form.

MORE LIGHT ON RADIUM.

The interesting field of research opened by the discoveries of the Curies has naturally started many other physicists in this direction. Radioactive materials are being studied actively and from many points of attack, and we are beginning to profit by this energetic campaign.

Radioactive Emanations May Be Condensed.

One of the most interesting announcements made recently, resulting from the work of Mr. E. Rutherford and Mr. F. Soddy, is given in a recent issue of the *Philosophical Magazine*. Assuming that the emanations from radioactive bodies were vapors, they attempted to condense them, with marked success. A slow stream of hydrogen or oxygen or air was passed over the radioactive material, and then through a spiral tube which could be cooled by various cooling mixtures. This current of gas showed radioactive properties until very low temperatures were reached. Even solid carbon dioxide did not affect it, but when liquid air or frozen ethylene was used, the current of gas lost entirely its radioactive properties. By removing the refrigerating material and allowing the spiral to warm up slowly, a temperature was reached where the gas again became radioactive. This temperature was sharply defined.

Effect Not Due to Occlusion.

These experiments seem to prove that the emanations from radioactive materials

are really vapors which are condensed at very low temperatures, although the quantity condensed was too small to be perceived. This view is strengthened by the fact that the radioactive emanation can not pass through the tube if the temperature is below a certain point; but that which is caught in the tube can be removed entirely if the temperature is raised a few degrees. This would indicate that there is an actual condensation, and not merely an occlusion.

The Boiling Points.

The experiments prove that the boiling point of the thorium emanation is minus 120 degrees, and that of radium is minus 150 degrees. There seems to be some connection with the difference in the boiling points of the two emanations and the fact that thorium loses its activity in a few minutes, while radium requires as many days.

The Life of Radium.

Messrs. Rutherford and Soddy, using the results of their work, have made some interesting calculations concerning these substances. The energy of a projected positive ion is 10^{-5} ergs, while that of the negative electron is much smaller. The mass of the negative electron is known from Professor J. J. Thomson's work; and assuming that of the positive to be the same, this sets a limit for the number of positive electrons each atom is capable of furnishing to the particles it projects. This limit they have placed at 200. Knowing the number of atoms in a gramme of radium and the rate at which energy is given out, an estimate has been made by them of the length of time it will take for any given atom to exhaust its radioactivity. The results indicate that for one gramme of uranium or thorium, more than a million years will be required to change one milligramme, but for radium the same change will take place in about one year; and that, therefore, any radium which exists is not more than one thousand years old.

What Becomes of the Lost Material?

These conclusions suggest an interesting question—What becomes of this lost substance? This emanation is the radioactive body, but it loses its activity from contact with the air or other substances. However, some final product must be left. This, Messrs. Rutherford and Soddy suggest, may be helium. The study of radioactive materials has been fascinating the physicists, and it now bids fair to become equally attractive to the chemists, and to modify considerably some of our ideas of the immutability of the atom.

THE ELECTROLYTIC TREATMENT OF GALENA AND REDUCTION OF LEAD.

BY ALEC A. BEADLE.

Galena (PbS) is a black crystalline mineral with a high specific gravity. It is generally associated with calcite and heavy spar and the whole mineral can be easily broken up and the galena concentrated out of it. The galena itself is always associated with more or less silver sulphide, forming in all probability a real double sulphide, and the mass is a very fair conductor of electricity. Such sulphides in fact seem to form a bridge between metallic and electrolytic conductors as they are capable of conducting electricity without suffering decomposition when solid, or of suffering electrolysis to a more or less extent when dissolved as double sulphides or when fused. Galena can be fused, cast into plates and used as electrodes, under which circumstances it suffers decomposition, either oxidation or reduction, according to whether it is used as anode or cathode. There are several ways in which attempts have been made to reduce galena, and these will be treated separately and in the order of their principle.

If it is partially roasted, part is converted into sulphate, or if roasted with salt part is turned into chloride and may be leached out with water containing sodium chloride in solution. Only a small proportion of the galena is thus brought into solution, and then we are confronted with the difficulty of depositing the lead in a coherent form, which so far does not seem possible. Altogether we may safely conclude that processes based upon these principles have no industrial future before them and can not compete with the present methods of lead smelting.

Another way in which the problem has been attacked is by using plates or slabs of galena as electrodes in an electrolytic bath of a salt containing the lead either as a base or as an acid. Moreover, the galena has been used as both anode and cathode, which may sound strange. If, for instance, the galena be anode in a solution of lead chloride or nitrate, the lead is dissolved, leaving most of the sulphur behind unoxidized as a badly conducting crust, the lead passes over to the cathode where it is deposited in a spongy condition and has to be collected, cleaned, pressed into cakes and smelted down, an operation involving both expense and waste. If a solution of plumbate of soda be used in place of lead chloride similar results are obtained, but more of the sulphur is oxidized.

If, however, the galena be used as cathode in an acid solution a somewhat more complicated reaction takes place and the lead is reduced to the metallic state *in situ*.

Perfect as this reaction may be it does not furnish all the essentials necessary to a really commercial process. The metal, although obtained in a metallic state, is far from being in a marketable form and has to be melted down and purified and freed of its precious contents by some well-known process, thus involving the main part of the difficulties inherent in the existing methods. The author has already pointed out[1] that by far the most likely principle for the reduction of lead from galena lies in the electrolysis of the fused chloride or by the replacement of the metal from the fused chloride by a more electropositive metal which can itself be reduced electrolytically, thus forming a cyclic process. The advantages of this method of procedure are many and some of them obvious. The chloride fuses at about 262 degrees centigrade, and although presenting several minor difficulties it can be electrolytically reduced, using a carbon anode and a fused lead cathode, if the temperature and current density are carefully regulated. It is almost entirely dehydrated when fused and thus does not give rise to the difficulties due to the water retained, even at a red heat, by some other salts. Since the current density can under such circumstances be very high, the vat can be so arranged that all the required heat is supplied by the extra voltage needed to maintain this current density, and thus external heating can be dispensed with. The chief advantage of the electrolysis of the fused chloride over that of aqueous solution is the fact that the lead is obtained in a marketable form direct, as it can be run in a melted condition straight into the ingot moulds. Gold and silver contained in the fused chloride can be removed as a rich alloy in the first portions of lead deposited, and there seems little reason to doubt that certain impurities,

[1] Electrometallurgical Problems, *Electrical Review* (London), October 10, 1902.

such as small quantities of arsenic and copper, will ultimately come under control of the operator so as not to be reduced in the bulk of the lead.

Unless the galena can by some easy and inexpensive means be converted into the fused chloride of lead, we should obviously be no nearer the mark than before. This second part of the problem has, however, received a great deal of attention of late and bids fair to become a new and separate branch of metallurgical chemistry. It would take too long here to enter into the details of the reactions involved or the history of the investigations which have been made in this most interesting departure, but it may be pointed out that there are important reactions which take place between metallic sulphides, chlorides and chlorine itself, all in an anhydrous condition and at an elevated temperature which promises to furnish a practical means of converting galena into fused chloride of lead direct. If dry chlorine be passed over galena at a temperature slightly below about 700 degrees centigrade, chlorides of both lead and sulphur are formed; if the temperature of the reaction be raised much above this value and care taken to supply a good excess of galena, chloride of lead and free sulphur are produced. The former reaction is at the base of the Larsen process, the latter is involved in the Swinburne-Ashcroft process. These reactions are, moreover, exothermic, and if performed on a sufficiently large scale require no external heat. It will be seen, then, that they may become part of a cyclic process in which fused chloride of lead is electrolyzed, and chloride evolved only to be used, as it were, as a carrier of the lead from the galena itself to the cathode of the electrolytic vat. A reaction also occurs between galena and fused zinc chloride, in which zinc sulphide and lead chloride are formed. Ganelin proposed to make use of this reaction direct, by reducing it with metallic zinc, but the action is incomplete and the lead is produced at the expense of the zinc, which unless converted into a pure fused chloride can not be economically reduced again for reemployment in this way.

At the annual meeting of the British Iron and Steel Institute, Mr. J. E. Stead submitted a note on the alleged cementation of iron by silicon announced by Moissan and Lebeau. Mr. Stead's experiments show that at temperatures between 1,100 and 1,200 degrees centigrade solid iron and free silicon do not combine, and that cementation by silicon is impossible when the iron and steel operated upon are in solid masses.

ELECTRIC FURNACE METHODS OF IRON AND STEEL PRODUCTION.

(Concluded.)

BY JOHN B. C. KERSHAW.

The Ruthenberg Furnace and Process.

The Ruthenberg furnace is the most recent addition to the list of electric furnaces designed for iron and steel production, and possesses several features of a novel character. The following details and the views of the small experimental furnace in operation at Lockport, N. Y., are taken from the illustrated article by the inventor, appearing in the February (1903) issue of *Electrochemical Industry.*

The principle of the furnace consists in the use of magnetic force to hold the crushed ore and carbon in suspension between two rolls, which function as electrodes, and in the use of resistance heating to raise the finely divided particles of ore and carbon to the temperature requisite for smelting. Within the heating roll are placed the opposing poles of an electromagnet. The ore is carefully selected and cleansed from gangue, etc., is finely crushed, and after mixing with the calculated amount of carbon is fed between the rolls. The magnetic action of the rolls holds a bridge of ore and coke in the narrow gap. This bridge acts as a path for the electric current, and is therefore raised to a red heat, and the ore is reduced. The weight of ore and coke above it and the revolution of the rolls then cause the reduced mass to fall in a semi-molten condition into a collecting trough, and a fresh bridge of raw material takes its place between the rolls. The metal produced requires smelting and refining in an open-hearth steel furnace. Figs. 6 and 7 show the apparatus from two points of view. The magnetic poles are placed within bronze revolving rolls and are water-cooled. The rolls are driven by a small motor and worm-gearing at four revolutions per minute, and the peripheral speed is about sixteen feet per minute. They carry 700 amperes of current at fifty volts. According to the inventor one ton of iron or steel can be produced by his process from suitable ores, with an expenditure of only 500 kilowatt-hours and at a cost fifty per cent below that required for the ordinary blast furnace procedure. As already stated, an experimental furnace has been erected and operated at the works of the Cowles Electric Smelting Company, at Lockport, N. Y., and its operation was witnessed by a large number of steel makers, on January 15, 1903. It does not appear that any larger developments of this interesting and novel furnace and process are yet in course of realization; but if the figures published by the inventor be correct, the furnace and process will doubtless receive industrial trial at Niagara or some other cheap centre of power in the United States.

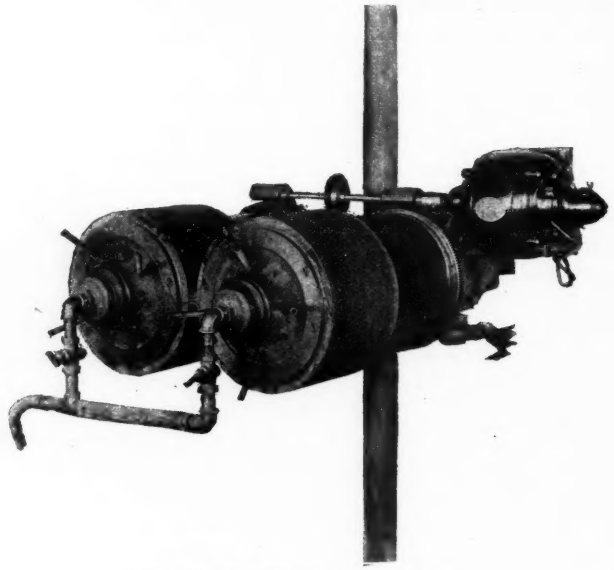


FIG. 6.—THE RUTHENBERG FURNACE.

The Stassano Furnace and Process.

The Stassano furnace was one of the first designed for the smelting of iron ores by the aid of electrically generated heat, and consequently there is more information available for publication concerning this furnace and process than for those previously described. Fig. 9 shows the earliest form of the Stassano furnace, and Figs. 10 and 11 show the latest form of furnace in sectional

elevation. The principle of the Stassano furnace and process is the use of the electric arc for heating the mixtures of ore, coke and lime; and as this involves intense localization of the heating zone, it becomes necessary to grind the ore and other raw materials, and to introduce these into the furnace in the form of briquettes.

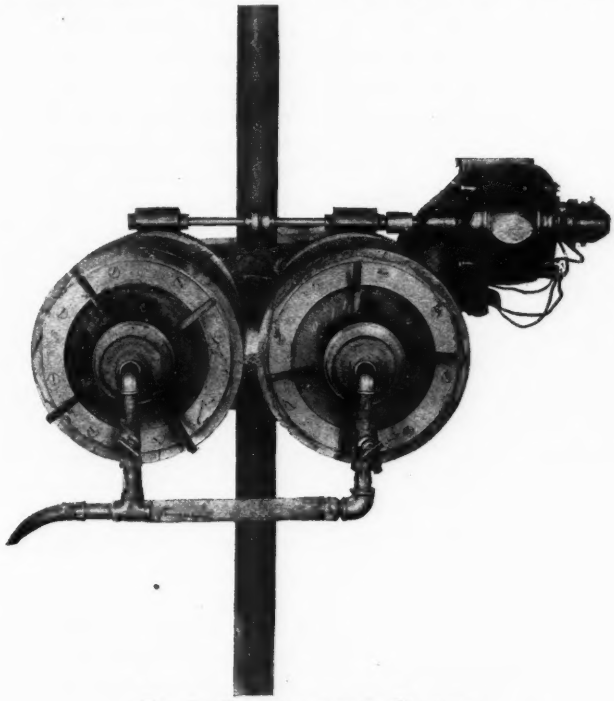


FIG. 7.—THE RUTHENBERG FURNACE.

In the latest form of furnace, shown in Figs. 10 and 11, a rotating hearth is provided, and sliding brushes at B and C convey the electric current from the fixed terminals of the current mains to the water-jacketed carbon electrodes AA. These electrodes are movable, and after the arc has been struck within the furnace they can be gradually moved apart until the arc strikes across the whole width of the furnace. The axis of the furnace is placed slightly out of the vertical line, and as the hearth revolves a mixing motion is given to the molten charge resting upon it. The arc is allowed to play over the surface of the charge and the heating thus occurs by radiation.

The charging hopper and tapping vents for metal and slag are seen at D, E and F, respectively, in Fig. 11. The Stassano furnace and process were first operated at Rome in 1899 and a power consumption of 2,700 electrical horse-power-hours per ton of steel was reported. As these early experimental trials proved successful a plant designed for utilization of 1,500 horse-power was erected at Darfo, in northern Italy, in 1900. An output of 4,000 tons of steel per annum was expected from this plant, but it is doubtful if anything approaching this quantity of steel has yet been produced at Darfo. Dr. Goldschmidt, of Essen, Germany, has twice visited this plant, and has reported very fully upon it for the German Patent Office. The following facts and figures are taken from Dr. Goldschmidt's report, full details of which will be found in the *Zeitschrift fur Elektrochemie* of February 5, 1903.

Wood charcoal is used for making the ore briquettes, and the furnaces are lined

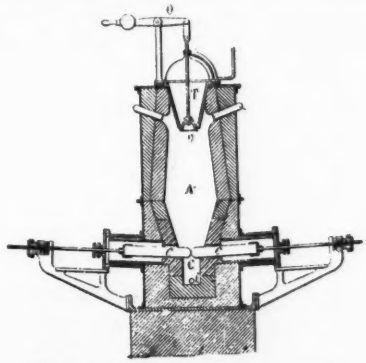


FIG. 9.—THE STASSANO FURNACE.

with magnesite. The actual working space inside the furnace is only one cubic metre. The carbons project into this, and carry 2,000 amperes at seventy volts. The charge is gradually introduced, and the strength and intensity of the current are slowly raised to the maximum, while the carbons are at the same time separated, until the arc is striking the full width of the furnace. The reduction, with a normal furnace charge, lasts about two hours.

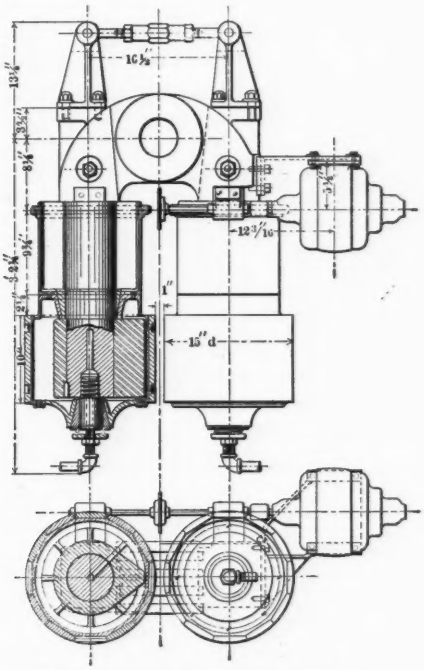


FIG. 8.—THE RUTHENBERG FURNACE.

In one experimental run, 97,200 watt-hours were required to smelt 70.25 kilogrammes of ore (containing forty-six kilogrammes Fe_2O_3) admixed with 3.263 kilogrammes of lime and 8 kilogrammes of coke (representing 7.23 kilogrammes carbon). The yield in this run was 30.8 kilogrammes of wrought iron.

Comparing the actual with the theoretical figures, Goldschmidt has calculated that the reduction in this case was obtained with a calorific efficiency in the furnace of 61.3 per cent.

Assuming that the efficiency of larger furnaces could be increased to sixty-six per cent, he gives a detailed estimate of the cost of a ton of iron by the Stassano process, which amounts to $18.04. This estimate is based on power at $7.68 per electrical horse-power-year, and upon Italian prices for raw materials and labor; and it would be increased to $26.88 per ton of iron in Germany, owing to the higher cost there of power and of iron ore suited for treatment by the Stassano process. The iron and steel produced by the Stassano process are remarkably pure, and Goldschmidt gives tests of the product, which show from 0.04 to 0.17 per cent of carbon, and only traces of silicon. The latter impurity, with manganese, sulphur and phosphorus, is stated to be nearly all removed in the slag.

It is interesting to compare Goldschmidt's figures for the Stassano process as worked at Darfo with those originally published for the earlier trials at Rome. These showed a consumption of 2,700 electrical horse-power-hours per ton of

steel, and the cost was given as $19.20 per ton. Although fifty per cent more power was required in the experimental runs witnessed by Goldschmidt, at Darfo, the total estimated cost is reduced from $19.20 to $18.04 per ton, a somewhat striking change in the estimate.

It is stated that $190,000 has been expended upon the development of the Stassano furnace and process, but according to Danneel of the *Zeits. f. Elektrochemie,* it may still be regarded as in the experimental stage of its development, and the company which has found the funds for the experimental plants at Rome and Darfo has not yet received any return upon its capital outlay.

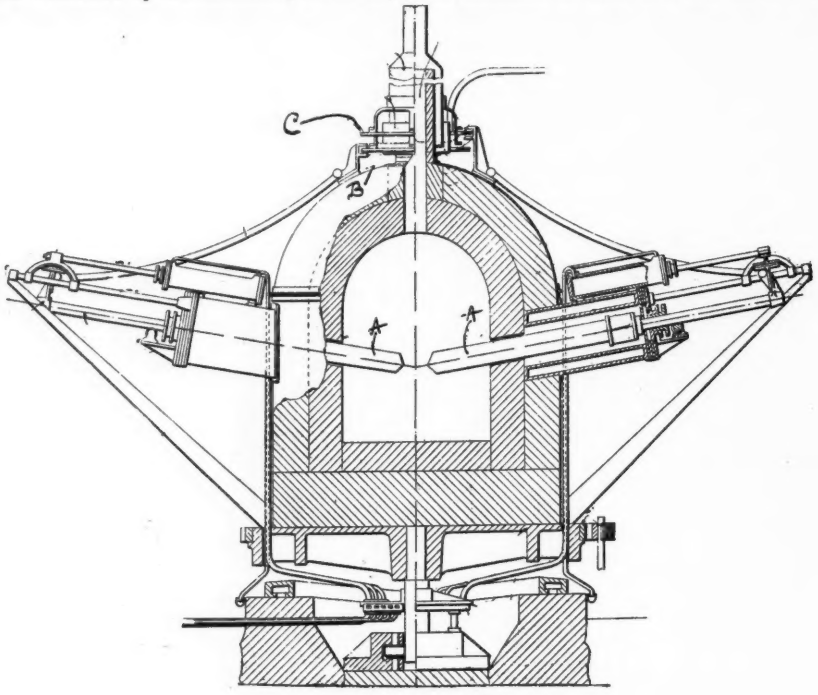


FIG. 10.—THE STASSANO FURNACE.

Conclusions.

Using the figures given by the inventors or by those exploiting the various processes described above, the writer has reduced them all to a common basis for comparison; namely, the electrical horse-power-hours required to produce one ton of iron or steel, and has obtained the figures given below:

Name of Furnace or Process.	Electrical Horse-Power-Hours per Ton of Iron or Steel.	Remarks.
Ruthenberg	680	.....
Conley	1,200	.....
Stassano	2,700	Early trials at Rome
Harmet	3,600	.....
Keller	3,800	.....
Kjellin & Benedicks	3,910	.....
Stassano	4,290	Later trials witnessed by Goldschmidt at Darfo.

It is evident that with such widely varying estimates of the power required in these furnaces to smelt one ton of iron, the estimates of total cost will differ within wide limits, and therefore one is not surprised to find the following figures:

Harmet, $5.60; Conley, $11.80; Keller, $18.40; Stassano, $18.04 and $19.20.

That the above estimates of power consumption and cost are somewhat unreliable is evident, not only from the wide variation, but from the fact that the total costs per ton of iron for furnaces and processes consuming over 3,000 electrical horse-power-hours are lower, in some cases, than for furnaces and processes consuming under this limit.

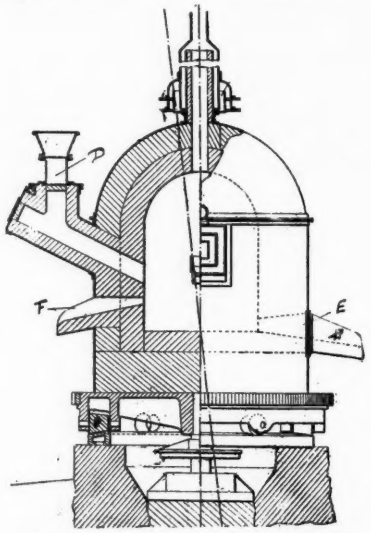


FIG. 11.—THE STASSANO FURNACE.

Discarding, therefore, the above figures as of little value in attempting to forecast the future of these processes, it is of interest to study the electric processes wholly from the general and practical standpoint. In all electric iron-smelting processes, the actual reduction is effected by the coke or other carbonaceous matter with which the ore is mixed; and in most cases an addition of lime or other fluxing material is required, in order to form a slag that will carry off the silicious and other impurities of the ore. The amount of coke actually required to reduce the ferric-oxide in iron ore, when working under the ordinary blast-furnace conditions, is stated by the best authorities to be 6.45 hundredweight per ton of iron produced; one may therefore safely assume that this figure approximates to the weight which will be required in the electric furnace methods of reduction. The total weight of coke required per ton of iron in the blast furnaces of the present day is, however, only sixteen hundredweight, and the saving effected by the substitution of electricity for coke as the heating agent is therefore equal to 9.5 hundredweight of coke per ton of iron produced.

The average price of coke in the United Kingdom is $5.28 per ton, and therefore the electrical power required to produce one ton of iron by any electric furnace process in Great Britain would have to be provided for $2.50, if the newer processes were to be enabled to compete with the old blast furnace procedure. Taking the lowest estimate of the power required to produce one ton of iron, 680 electrical horse-power-hours (that given by the inventor for the Ruthenberg process), this equals electric power at $30 per electrical horse-power-year. For the electric furnace processes, requiring over 3,000 electrical horse-power-hours per ton of iron, the cost of the electrical horse-power-year would have to be as low as $7.25, to enable them to compete in the United Kingdom with the ordinary blast furnace procedure. These calculations prove that even when no special crushing of the ore, and mixing with the fluxing, reducing and binding materials are required, as a preliminary to the electric furnace process, competition with the ordinary blast furnace methods in countries well situated as regards supplies of fuel (that is, in the United Kingdom, Germany and America) is improbable. When briquette making is an essential preliminary, the position of the electric furnace processes would appear to be hopeless in such countries. The one exception to this judgment is the Ruthenberg process and here the experimental trials upon which the

estimate of 680 electrical horse-power-hours per ton of iron are based would appear to be too limited in scale to render the estimate of great value. Further trials upon a larger scale of operation, with this process, are therefore called for, and will doubtless be made.

In countries where fuel is very expensive, water power abundant, and the necessary raw materials—iron ore and limestone—are abundant, the position is different, and the electric furnace processes described above may have a limited field of usefulness. Development even under these favorable conditions will, however, be dependent upon the enforcement of high tariff duties on imported iron and steel, and upon a brisk home demand for these metals. Whether the governments in Italy, Norway and Sweden, and similarly situated countries of Europe, will provide the tariff conditions required to enable these new electric furnace processes of iron and steel production to develop and flourish, remains for the future to disclose. Should such facilities not be granted, the development of electric furnace methods of iron-ore reduction will be slow, and the use of water power on an extended scale in the iron-smelting industry, in the writer's opinion, will be postponed to that date in the future when the coal fields of Europe and America are approaching exhaustion.

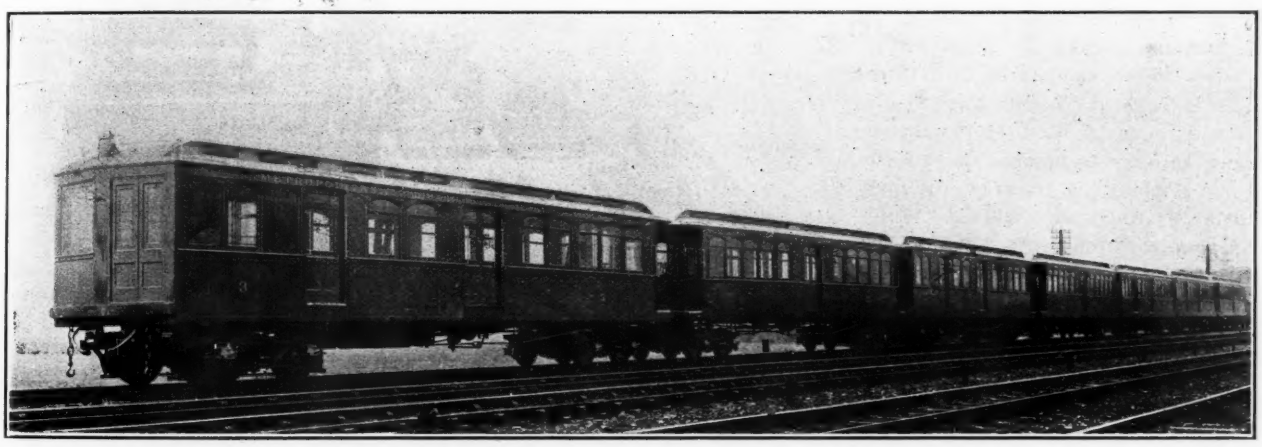
M. Henri Becquerel, Paris, and Professor A. Righi, Bologna, were elected honorary fellows of the Physical Society of London at the last general meeting of that body.

During the discussion at the recent convention of the National Electric Light Association, at Chicago, powdered bismuth was mentioned as a curative agent for electrical burns.

THE ELECTRICAL EQUIPMENT OF THE METROPOLITAN DISTRICT RAILWAY.

(From Our Special Correspondent.)

Tangible progress has at length been made on the electrical equipment of the Inner Circle Railway, and experiments are now being made upon a short section of railway some seven or eight miles long, the principal object of which is, at present, to determine the type of control which shall be adopted. Both the Westinghouse electropneumatic system and the Thomson-Houston Sprague system of train control are no doubt sufficiently well known to Americans to need no further details here, but a short description of the cars will no doubt prove interesting. Two trains of these have been built by the Brush Electrical Engineering Company, of Loughborough, and have recently arrived on the confines of the District system at South Harrow, where they are being fitted with their electrical equipments prior to being experimentally run over the new line between Harrow and Ealing. Both trains are being equipped with multiple-unit train-control apparatus, the one by the British Thomson-Houston Company and the other by the Westinghouse Company. When fitted, the two trains are to be run in a series of trial trips on the Harrow and Ealing line to decide which system of train control is the better.



TRAIN OF MOTOR CARS AND TRAILERS, METROPOLITAN DISTRICT RAILWAY, LONDON, ENGLAND.

Each of the trains is made up of seven cars, three of which are motor cars and the other four trailers. The motor cars are placed at each end of the train and in the middle. Nearly all the electrical apparatus is carried under the floor of the car, so that, with the exception of a small cabin for the motorman, the entire length is available for the conveyance of passengers. On the front and back motor cars a space for the storage of luggage is provided adjacent to the motorman's cabin.

The design of the cars is obviously American, and nothing like them is at present to be seen on British railways, except on the tubes. They are painted externally a bright yellow. They differ from the Central London cars, and resemble those of the Great Northern & City, in having side doors in the centre, as well as end platform doors of the ordinary American type. These side doors slide, and are provided with handles, so that they can be worked either from within the car or from the station platforms. Experience will decide whether they shall be used at every station or be treated as a kind of emergency exit, and for emptying the trains quickly at the termini. The exits at the ends of the cars are protected by gates which are operated by a conductor standing on the car platform, after the style made familiar to Londoners on the "Twopenny Tube." The advocates of this type of passenger car claim that it saves much time in the station stops, as compared with the ordinary British type of compartmental cars with separate side doors. It is also very useful to have a conductor on each car, to make the passengers move quickly and to call out the names of the stations. It is considered that what the Americans know as "rapid transit" is not possible without end-door cars. This system logically involves the abolition of all distinctions of class except "smoking" and "non-smoking" and, judging by the trains at Harrow, there will be only one class on the electrified district; but it is understood that no final decision has been come to on this point.

The cars are each fifty feet long, have seats for forty-eight passengers in the trailer cars, and for a few less in the

motor cars. All the seats in the cars at Harrow are along the sides, as in a tramcar, and a broad gangway runs right through the centre. There is plenty of room for standing without inconveniencing those sitting down, which can hardly be said of an ordinary compartment on a suburban train. No doubt if the Londoner be given real "rapid transit," he will not mind standing sometimes. To a certain extent this view is borne out by the experience of the Central London.

There is practically no cloth or stuffing in the upholstery of the new cars, all the seats being covered with rattan. In selecting the materials employed, two objects have been kept paramount—cleanliness and protection from fire.

All the wood used for the cars has been treated by the patent "non-inflammable" process and the ceilings are lined with asbestos. The seats are probably not so comfortable to sit upon as in many English railway carriages, but it should certainly be much more easy to keep them clean. A novel feature are the electric heaters, of which there are sixteen in each car, fixed under the seats, with a regulator at one end of the car. It remains to be seen whether this innovation will commend itself to the British public. In order to promote quick starting and stopping, the trains are equipped with the Westinghouse air brake. All together the cars constitute a radical departure from the ordinary British practice, and the experiment will be watched with great interest.

The Westinghouse equipment of the one train is two motors of 150 horsepower each, one motor being of standard Westinghouse railway type. The track at South Harrow is of the ordinary standard steam railway gauge, with the addition of electrical conductor rails, one of which is between the running rails and the other sixteen inches outside the running rail, there thus being a complete circuit of which the ordinary rails form no part, contrary to what is the case on the Central London Railway.

In addition to comparing the two systems of control, the section of line upon which the trials are to be made will be utilized ultimately to train the motormen.

A. W.

London, May 30.

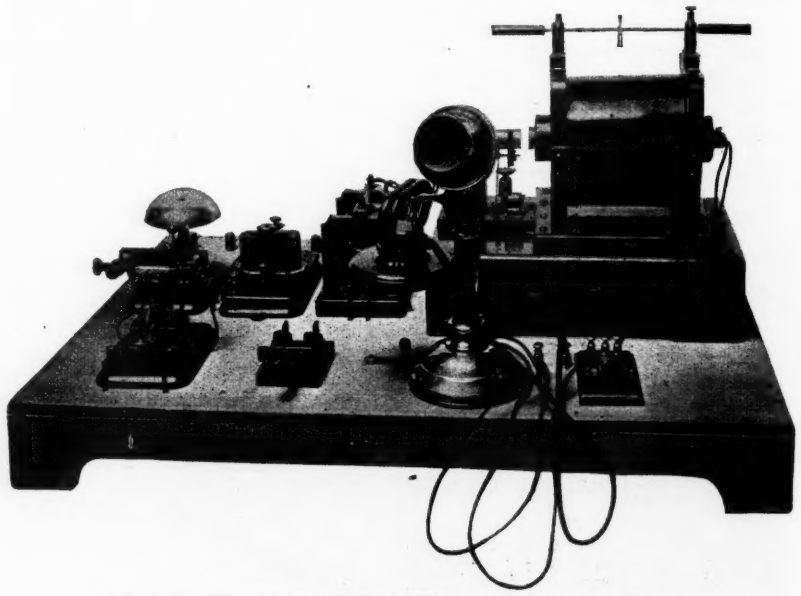
Motor Van for the Collection and Delivery of Railway Goods.

Particulars are given in a recent article in the London *Railway News*, May 23, of the actual experience of one of the English railway companies in the employment of a steam motor wagon for transferring and collecting heavy freight. The van in question has been in regular employment for the past six months, plying between a railway freight station and a mill two and one-half miles distant therefrom. At first the steam van only was used, but subsequently this was supplemented with a trailer. Four trips are made daily, for which loads are available one way only. There is a heavy grade against the load. The motor alone can carry from fifteen to sixteen tons daily, and with the trailer, from twenty to twenty-four tons are hauled, the average load per journey being between five and six tons. Two men are sent out with the van, as against a man and a boy with a horse vehicle; but the van takes the place of four single-horse wagons. The cost of these teams had been kept separately, so that exact comparison was possible with the cost of the steam van; and after six months' experience, the railway authorities are satisfied that there is a saving in the employment of the latter. The cost of repairs to the motor, however, is still an unknown quantity, and should this be high as time goes on, and the parts wear out, the saving at present may be converted into a loss. The experience with this van indicates that for hauling heavy loads between fixed points, motor vans are more economical than horse traction; but where freight must be handled in small loads, and distributed from point to point, single-horse drays give the best service. Under these conditions, the advantage which might be derived from the superior speed of the motor van is not realized, because of the frequent stops necessary in distributing the freight.

Wireless Telephony on Ferryboats.

A test of the Collins wireless telephone system was made recently on two ferryboats belonging to the Erie Railroad, and running from New York to Jersey City. Although the arrangements for this test were not entirely satisfactory, as sufficient ground plates had not been provided, communication between the two boats was found possible over a distance of several hundred feet. Messages were sent one way only, but one set of sending apparatus being available.

The accompanying engraving shows the apparatus used in these tests. This shows the coherer, tapper and call bell used for signaling, the relay, and the induction coils and spark-gap arrangement, with the telephone transmitter and receiver. The latter, it will be noticed, is of a new type, and has been designed by Mr. Collins particularly for this service.



APPARATUS USED IN THE COLLINS WIRELESS TELEPHONE SYSTEM.

It is not the hope of the inventor of this system of wireless telephony to replace the ordinary wire system, but he thinks there is a wide field for its application in harbor service, where it is necessary to communicate frequently and quickly between two vessels separated by only a few hundred feet; and he believes that this system is admirably adapted for such service. Much greater distances than those mentioned have been covered by this system in land tests, as described in the ELECTRICAL REVIEW for November 29, 1902, during some tests made at Rockland Lake, N. Y., and from the inventor's experience in these tests, he is confident that, with suitable arrangements, there will be no difficulty in communicating between vessels separated by 600 or 700 feet.

The Pueblo & Suburban Traction and Lighting Company, Pueblo, Col.

By J. H. Rusby.

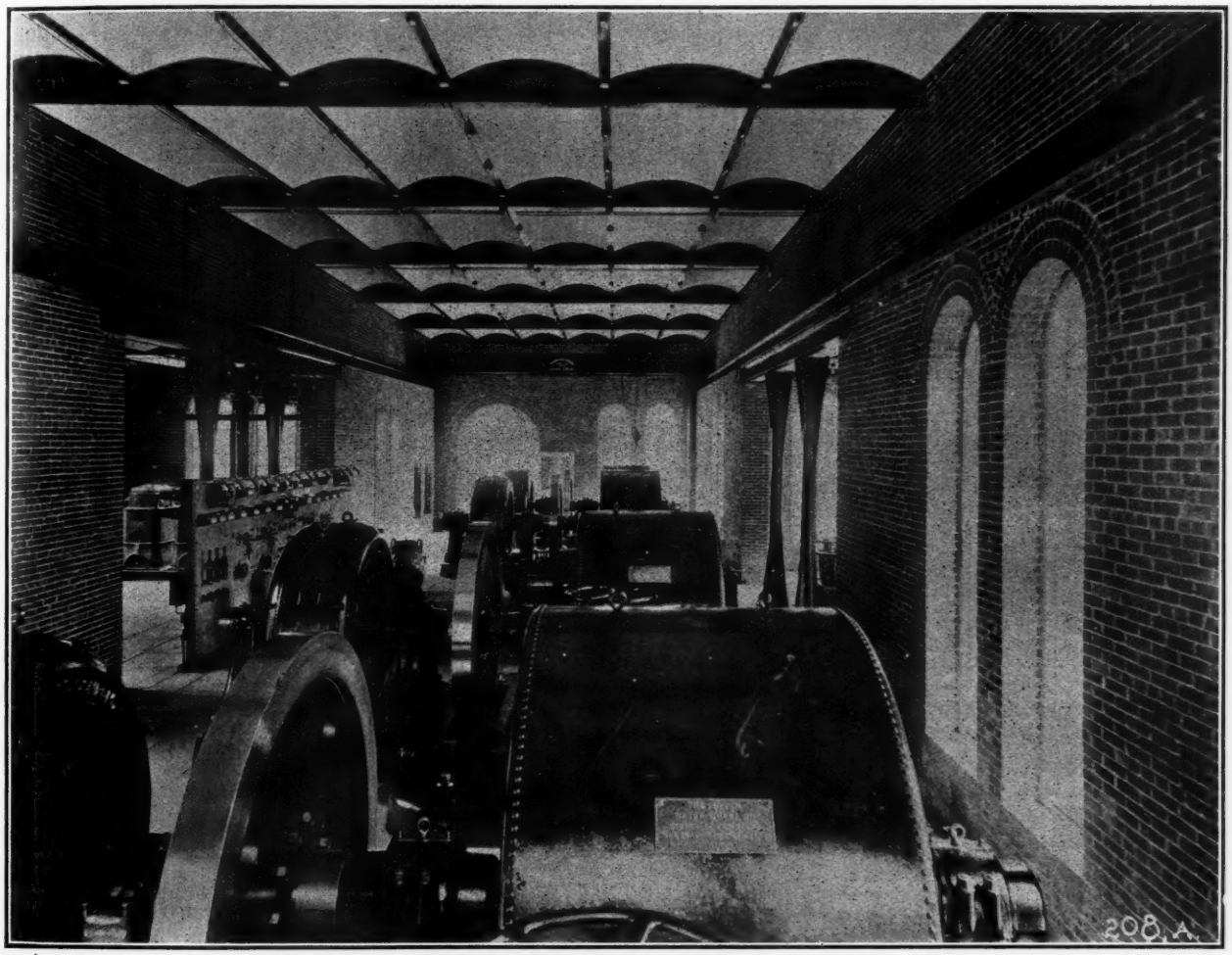
THE street railway, electric light and electric power systems of Pueblo, Col., were formerly owned by the Pueblo Traction and Lighting Company, a corporation organized January 1, 1901. This company acquired by purchase all of the street railway, electric light and electric power systems of the city from the Pueblo Traction and Electric Company, the Pueblo Electric Street Railway Company, and the Pueblo Light and Power Company; all of the street railway, electric light and electric power business of the city of Pueblo being owned and operated by the Pueblo Traction and Lighting Company from the date of its organization until December 1, 1902, when the property was sold to the Pueblo and Suburban Traction and Lighting Company. The major part of the property has been rebuilt within the past two years, bringing the entire system up to the most recent developments of modern construction.

The power-house is located in the centre of the system, in the central part of the city, within 200 feet of the Arkansas River, from which steam water is received, through a sixteen-inch pipe, for condensing and other purposes; and because of the central position of the power-house, power can be distributed in all directions with a small percentage of energy loss.

The main power-house building is 125 by 140 feet, constructed of brick and stone, with structural steel and tile roof, and cement floors. The building is fireproof, and is divided in the centre by an eighteen-inch brick partition wall, separating the boiler room from the engine room.

The main car-house is situated south of the power-house. The dimensions are 115 by 165 feet, with ten tracks entering the building from the street, and has a storage capacity of forty forty-foot double-truck cars. This is a fireproof brick and stone building, with steel and tile roof, and rolling steel doors.

The storage battery building adjoins the main power-house on the engine room side, with a door opening into the engine room. This building is also of fireproof construction, with a cement floor. The pump-house adjoins the main power-house, and contains boiler feed pumps, condenser pumps, condenser engines, water meters, etc.

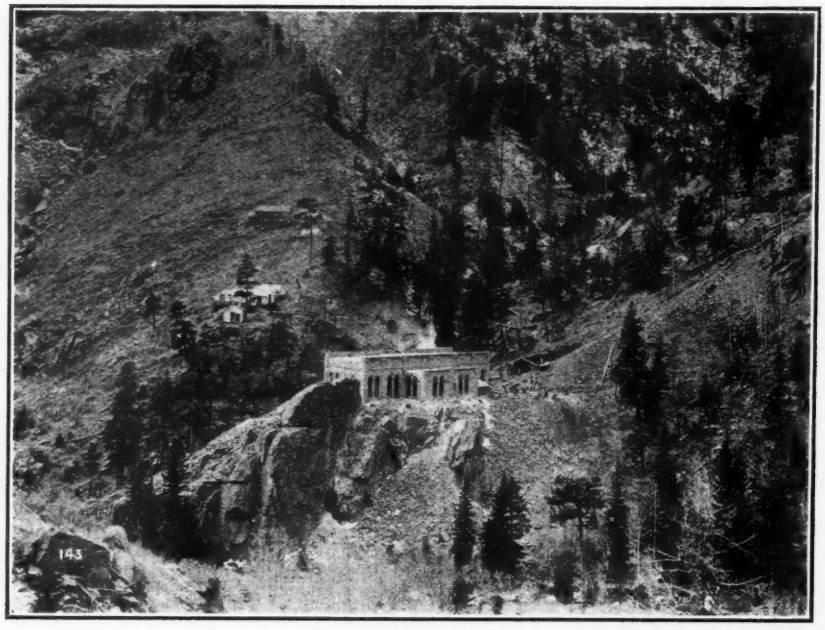


Power Plant, Station "A," Pueblo & Suburban Traction and Lighting Company.

The engine room is 60 by 140 feet, and contains five engines, with a rated capacity of 2,700 horse-power. Three of these are tandem-compound engines, manufactured by McIntosh, Seymour & Company, of Auburn, N. Y. One is a tandem-compound engine manufactured by A. L. Ide & Son, Springfield, Ill., and the remaining engine is a cross-compound Rice & Sargent engine, manufactured by the Providence Engineering Works, Providence, R. I. These are all direct-connected to General Elec-

tric railway and lighting machines, with a rated capacity of 1,700 kilowatts, with separate exciters. The entire engine room is served by a fifteen-ton traveling crane.

The switchboard is of modern construction, the panels being of blue Vermont marble for the lighting circuits, equipped with a full set of controlling apparatus; and of polished slate for the railway and power circuits. Adjoining the pump-house building is located a machine shop, electrical repair shop and storeroom, where all repairs are made, and supplies for the company's business carried in stock. The boiler room is 65 by 140 feet, equipped with eight Cahill high-pressure water-tube boilers, having a rated capacity of 2,600 horse-power. Coal is unloaded from the cars in front of the boilers.



STATION "A," USING WATER UNDER 1,165 FEET PRESSURE, PUEBLO & SUBURBAN TRACTION AND LIGHTING COMPANY.

The storage battery equipment for the railway and power circuits consists of 264 cells of chloride accumulator, with a capacity of 320 amperes, 550 volts, on the hour rating. The battery is used to carry the peak of the railway load, and to regulate the fluctuations of the railway and power lines. The battery and booster used in connection with this were supplied by the Electric Storage Battery Company, of Philadelphia, Pa.

The track consists of twenty-six miles, about one-half of which is laid with thirty-five pound and one-half with seventy-five-pound steel T-rail. The small rail is being replaced, as fast as it wears out, by the heavier construction. Cedar cross-ties are used, spaced two feet from centre to centre. The track is bonded with Brown-Edison amalgamated and wire bonds, all of which are under the angle joints.

The cross-suspension system is used, with poles on both sides of the street suspending the trolley and feeder wires, the former being of No. 0 hard-drawn copper. The company has twenty-six new double-truck cars, built by the American Car Company, of St. Louis, Mo., and the Woeber Carriage Company, of Denver, Col., with Brill trucks. The cars are all modern, of the combination type, one-half open and one-half closed, all equipped with General Electric motors. The company also has a number of single-truck nine and ten-bench open cars, which are used for rush trips and summer travel to the parks and other resorts in the city.

Power for electric light and operating motors is distributed throughout the city on overhead wires carried on cedar poles, ranging in height from thirty to sixty feet. The pole line has been almost entirely rebuilt within two years, using cedar poles from Idaho. The lines reach all parts of the city and suburbs.

The commercial arc lamps used are of the alternating-current type, General Electric and Adams-Bagnall manufacture. The streets are lighted by series open arcs. The company has a ten-year contract with the city of Pueblo for lighting the streets, dating from September 14, 1902. There are connected to the company's lines, and in operation in Pueblo, 264 street arc lamps and 383 commercial arc lights, 15,000 sixteen-candle-power incandescent lights, and seventy-two motors.

The franchise issued in the month of April, 1899, granted to the company the use of the streets of the city of Pueblo for a railway system for a term of forty-three years, and additional franchises have been granted since that time, all of which expire in 1940. A franchise was also granted in April, 1899, granting to the companies the right to furnish electricity for power, heating and illuminating purposes to public and private consumers in the city of Pueblo for a term of twenty-five years.

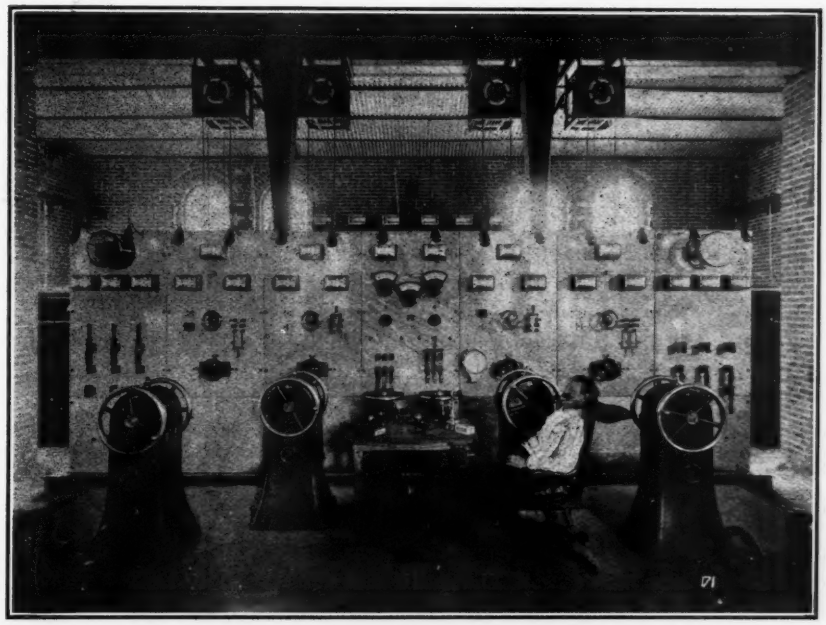
While the installation thus far described is of interest, as representing a progressive utilization of ordinary forms of energy, it is the water power development of this company which is of the greatest interest. The country surrounding the city of Pueblo and its suburbs is of such a nature that there is an almost unlimited future supply of energy from the water power available. The company owns patented lands on and along Beaver, West and East Beaver creeks, in Teller and Fremont counties, including reservoir sites and all water power privileges, covering, on the above streams, a total of eighteen miles. These streams are noted for the excessive difference in elevation in short distances. These streams drain an area of seventy square miles, having their head on Pike's Peak, at an elevation of 14,147 feet above sea level, and falling rapidly to 9,009 feet at what is designated as Reservoir No. 1. On the Beavers there have been located three power stations, "A," "B" and "C," which, when completed, will furnish 10,300 horse-power. Station "A" is now completed and in operation, transmitting current for power and light to mines, mills, trolley systems, etc., of the Cripple Creek mining district, as well as supplying the towns of Victor, Goldfield, Altman, Gillett, Anaconda, Cameron and Lawrence, where the company holds valuable franchises, and in each of which towns there have been established or will be established substations. This station, which has a capacity of 2,700 horse-power, is now being connected by high-tension lines to the main power plant at Pueblo, thirty-five miles distant.

The following information is by courtesy of Mr. R. M. Jones, chief engineer and general superintendent of the Pueblo & Suburban Traction and Lighting Company.

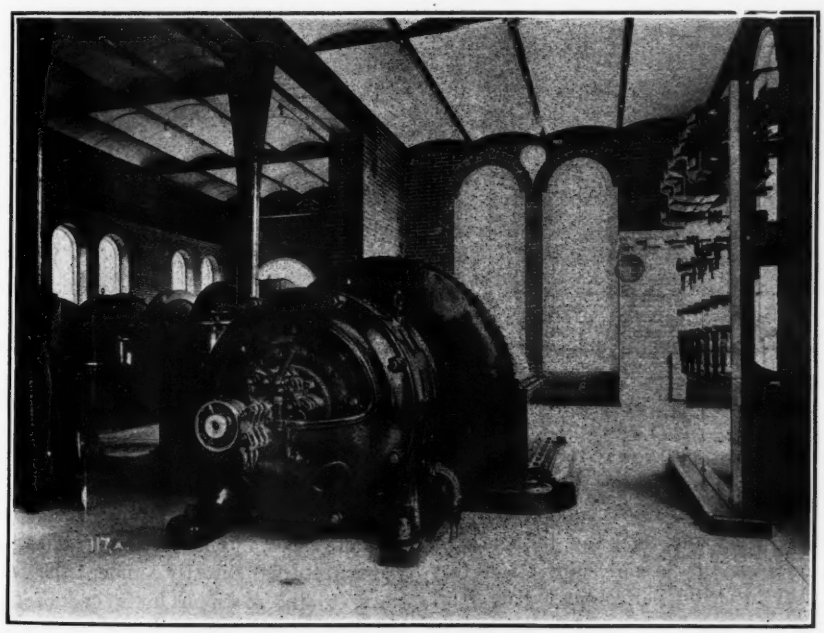
The dam and reservoir are located five and one-half miles east of Victor. The dam is of steel-faced granite-back filled

construction. The dimensions are 405 feet along the cap, 220 feet length of base, 148 feet cross-section of base, and 20 feet cross-section of cap. The upper slope—that is, the steel face—is thirty degrees from the vertical, and the lower slope, fifty degrees from the vertical. The height of the dam from bed-rock to the top of the sixteenth plate, which is a spillway level, is seventy feet. The spillway is sixty feet wide, cut in granite formation, and passes around the northwest end of the dam. The granite-back fill to which the steel plate is held is carefully laid in "dry wall" heavy granite boulders, usually of twenty to eighty cubic feet each, as broken from heavy blasting, with loose, fine granite filling the intervening space.

The steel plate is built of sheets five by fifteen feet, one-half inch in thickness for the bottom, eight plates in height. Continuing, the plate is reduced in thickness to three-eighths of an inch to the top of the eleventh plate, and finally, at the cap, it is one-quarter of an inch in thickness. The entire sheet is riveted up with horizontal butt straps, four by five by one-half-inch angle bars placed vertically the entire height of the dam, across each interval of five feet, across the entire length of the dam. The five-inch leg of each pair of angle bars projects into the reservoir, and constitutes a standing joint seam with an iron lining three-eighths by two inches, riveted between the extreme outer points of these angle bars, thus making a thorough expansion joint for each section of fifteen feet. The bottom and end connection of the entire sheet is concreted into a deep channel-way quarried out of bed-rock. The bottom terminates in two pairs of five by eight-inch angle bars, riveted through the plates. The end connections are prepared in the same manner, but are applied vertically. The quarrying of the bed-rock channels was carried out horizontally in each case to a point rising to an elevation, and then the rise was made abruptly in terrace form. The entire sheet is riveted and caulked in the same thorough manner as in boiler practice. A space of six inches was left between the steel plates and smooth surface of the granite-back fill. This narrow space is taken up by sand, gravel and sedimentary deposit, the filling being applied with ample water, and being permitted to dry before water pressure was allowed to enter the reservoir. The steel sheet is anchored securely to the face of the granite wall by means of one-half by six-inch steel cable, connected to the expansion joints by means of riveted loops, and the cables secured into the granite full by means of railroad iron passing through loops in the cables and embedded into the granite some thirty feet from the steel face.



SWITCHBOARD AND CONTROLLING STAND, INTERIOR OF STATION "A," PUEBLO & SUBURBAN TRACTION AND LIGHTING COMPANY.

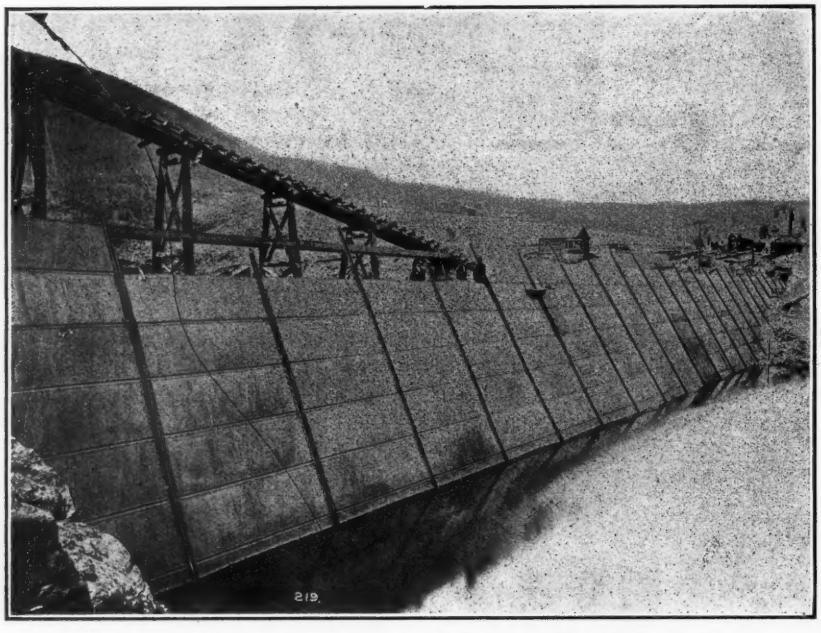


SIDE WING, INTERIOR OF STATION "A," PUEBLO & SUBURBAN TRACTION AND LIGHTING COMPANY.

The reservoir has a surface area of 140 acres. The banks or walls are steep, as indicated by the contents capacity of the reservoir, which is about 103,000,000 cubic feet at its sixteenth plate (9,081 feet elevation). Its capacity will be 193,467,640 cubic feet at the top of the twentieth plate, or 9,100 feet elevation. The entire basin forming the reservoir is tight granite formation. In pursuance of the plans laid out for the general extension of the whole system, the dam will be raised from the sixteenth to the twentieth plate during the year.

Water is taken into the wooden stave pipe through a "grizzley" 240 feet long, perforated by means of slots one-quarter of an inch wide and eighteen inches long, sawed in wood staves, giving thirty times greater area than the pipe. This "grizzley" is anchored firmly on a raised rock foundation. The connections between the "grizzley," and also the main pipe line, are connected to the steel facing of the

dam by steel anchor connections. The wood pipe is 23,200 feet long, thirty inches inside diameter, and is of one and one-half-inch redwood stave, banded with one-half-inch steel bands and cast-iron lugs. The bands are spaced at intervals along the pipe, at various distances, between two and one-quarter and eight-inch centres as necessary for resisting the internal pressure, variations in spacing being caused by various inverted siphons along the line, two of which reach 215 feet pressure. This pipe line extends over rough country, about one-half of the grade being through original granite formation, many of the curves of less than 100 feet radius, and one compound curve is thirty-five feet. The wood pipe passes



Steel Face of Dam, 520 Feet Long, 92 Feet High—Pueblo & Suburban Traction and Lighting Company.

through the Skagway tunnel, which is 1,533 feet in length, located at 21,000 feet from the dam. The tunnel is all of solid granite, requiring no timbering. The pipe leaves the dam at 9,018 feet elevation, but the water surface at its lowest usage is 9,025 feet, and reaches the south end of the Skagway tunnel at 9,011 feet, the mean gradient being 0.61 of a foot in a thousand feet, making the discharge capacity of the pipe 30.8 cubic feet of water per second. At a point on the pipe line 22,600 feet from the dam, and at the highest elevation of the pipe after the first 1,600 feet, directly at the south end of the Skagway tunnel, is located a tee of steel plate, five-sixteenths inch in thickness, from which a "riser" is extended vertically seventy-three feet. This reservoir is the wood stave pipe, thirty inches inside diameter, and its open top end is 300 feet higher than the sixteenth plate at the dam. This reservoir prevents "water ram" from increasing pressure in any pipe. Immediately below the "riser," and in the same concrete enclosure, is a thirty-inch gate valve for closing in case of emergency. There is also a thirty-inch gate valve in the pipe at the dam. From a point 300 feet below the Skagway tunnel, where the static pressure reaches 120 feet, the line consists of steel pipe twenty-nine inches in diameter, in various thicknesses of plates, ranging from one-quarter to three-quarters of an inch, as required to meet the internal pressure with an ample factor of safety. The total length of steel pipe, including the reservoir, is 2,900 feet, on an incline varying from twelve and one-half per cent to fifty-seven per cent. It passes over grades constructed through tough granite, at one point passing through an inclined tunnel 335 feet in length, just above which is a bridge seventy feet in height, both being on a forty per cent gradient. From the south end of the Skagway tunnel the pipe line is entrenched in the grade on which is constructed a three-foot gauge railway, leading from the Skagway tunnel to a power-house, its grade being 1,165 feet vertical in 3,100 horizontal. This road is the only means of access to the power-house. The cars are operated by a double-hoisting engine, the cable passing around gipsey rollers and over horizontal idlers. The upper terminus of the railroad lies under a vertical ledge seventy feet in height, and all machinery, apparatus and materials of all kinds were lowered by boom and derrick, taking loads from the wagon at the upper landing, and lowering them seventy feet over the ledge to the cars, from which point the loads were lowered by a friction brake on the hoist equipped with a three-quarter-inch cable.

The power-house at station "A" is 38 by 100 feet, with two side wings 16 by 48 feet each, and is located on the summit of a granite projection surfaced off smooth to grade. The building is fireproof constructed, of brick, with steel corrugated, arched roof, concrete, tar and gravel-covered concrete floor, and is served with a ten-ton traveling crane.

The hydraulic apparatus was manufactured by the Pelton Water-Wheel Company, of San Francisco, Cal. Each unit consists of two steel disc wheels, sixty-six inches in diameter, keyed on to the same shaft, and working in the same wheel-house. The base frames are built-up box patterns of the same type and general design as the generators to which they are connected. The frames of the water-wheels and the generators are faced for accurate, rigid connection to each other by bolts and dowels. The connection of water-wheel and generator shafts is effected by a 7,000-pound cast balance wheel, banded with a rolled steel tire four inches in thickness. The wheel is seven feet in diameter, and its hub forms a connection on the water-wheel shaft, and one-half of the hub forms the other half of the face coupling, and is keyed up to the revolving field shaft.

The nozzles for each unit vary in diameter, one having the capacity of the generator, and the corresponding nozzles for the other wheel in the same unit being somewhat reduced. Each wheel and each unit will produce power for the full capacity of the generator connected. The nozzles are of the deflecting type, and work under full pressure at all times. The regulation is of the Armstrong type, and due provision has been taken to extend the actual control and regulation of each unit to a point directly in front of the switchboard panel belonging to that unit. The receiver runs longitudinally through the building under the steel concrete floor. The discharge tail-race water returns directly under the receiver to the south or lower end of the building, at which point it will unite with water conducted from a point 800 feet above station "A," where a catcher dam is to be constructed, and the water diverted from the Beaver stream channel, the combined water being conducted through a pipe line two and three-quarter miles to station "B." There will also be

built a smaller pipe line up the east fork of Beaver Creek, to the same static level as the tail-race water of station "A." The waters of both pipe lines will be united before entering the receiver. The head at station "B" will be 1,252 feet, or 543 pounds pressure per square inch, and with an added accumulation of the water from the West Beaver branch and the East Beaver branch, a total of 5,500 horsepower may be developed at station "B."

WOOD STAVE PIPE, 30 INCHES IN DIAMETER, UNDER 215 FEET PRESSURE, NEAR NORTH END OF SKAGWAY TUNNEL, 22,600 FEET OF THIS PIPE—PUEBLO & SUBURBAN TRACTION AND LIGHTING COMPANY.

There are now in operation in station "A" four 400-kilowatt General Electric machines, three-phase, thirty-cycles, 600 volts, with stationary armatures and rotary fields, making 450 revolutions per minute; and two four-pole direct-current exciters having a capacity of thirty kilowatts, each running at 675 revolutions per minute. The exciting current is at a pressure of seventy volts, being sufficient for all four generators while working at full load.

The switchboard apparatus is liberal in design. It is made up of one exciting current panel, four generator panels, two distributing panels, two high-tension panels, and one paralleling or synchronizing panel. Each panel is made of Vermont marble, sixty-two by thirty-six inches, with subbases twenty-eight by thirty-six inches, and two inches in thickness, with a complete equipment of indicating and recording instruments, switches and regulating apparatus. The main line switches from each machine are operated independently, double-throw, either for power or light. The circuits are arranged so that any or all of the machines may be applied on either circuit. Six 250-kilowatt air-blast transformers of the General Electric type, having 600 volts on the primaries and 12,600 on the secondaries, are installed. There are also twelve single-pole lightning arresters. The cable connections between the generators and switchboard, and from the switchboard to the transformers, are all highly insulated, lead-covered, and laid in conduits in the concrete floor. Since the early operation of the station it was found necessary to install some thorough system for combined arc and incandescent lighting. This has been fully accomplished by the installation of two 200-kilowatt compensated three-phase generators. These generators are twelve-pole, and operate at 600 revolutions per minute, sixty cycles. Each generator is equipped with its own independent direct-current exciter, twelve poles, built directly on the revolving field shaft.

The line transmission from station "A" to the centre of distribution at Victor includes a distance of eight miles by pole line. The power circuits consist of three conductors, of No. 4 B. & S. gauge, soft-drawn bare copper, and the lighting circuits of three conductors of No. 6 B. & S. gauge, which are ample to deliver 1,600 kilowatts at less than five per cent energy loss. These lines are transposed at intervals of each one-half mile along the line. The poles also carry for telephone purposes two No. 10 galvanized iron weatherproof wires, transposed each 120 feet. The insulators are five and one-half inches in diameter, of porcelain, each made up of three independent cups. The line voltage is 12,600, both on thirty and sixty-cycle lines.

The substation at Victor is of fire-

proof brick and steel construction. All transmission circuits enter this building, where the current is transformed through nine fifty-kilowatt oil transformers, 12,000 volts primary, and 115-460 volts secondary, for local lighting distribution connected with a four-wire system. There is also a set of fifty-kilowatt oil transformers and a 120-kilowatt rotary converter. High-pressure distributing lines leave the substation in various directions, after first passing through 20,000-volt oil switches, making each line independent, to a number of industries throughout the district. In addition to the power and lighting distribution, the company operates a telephone system with a fifty-instrument equipment, thirty-three telephones operating at present. This system is connected by two trunk lines to the Colorado Telephone Company's switchboard, and working arrangements with that company enable connection with any part of the district or state. The general plan is to relieve the steam plant now operating at Pueblo of all the street railway load, using the steam only as a possible reserve. The insulation and all line work have been designed for continuous use at 40,000 volts. One of these circuits will be used on equipments operated at thirty cycles per second for running rotary converters, on railway work and power motors, either on direct 550-volt or three-phase 460-volt circuits. The other circuit will be used for sixty-cycle, three-phase, alternating arc and incandescent lighting, the switching arrangements at each end of the line permitting the use of either thirty or sixty-cycle transmission over either line.

A Reliable Tower Clock.

A booklet has been issued by Mr. E. B. Ferson, of the Chicago Manual Training School, describing the tower clock built by the students of that institution for the University of Chicago.

The clock has four dials, each four feet in diameter, and strikes the hours and quarters. The body of the dial will be of opal glass, illuminated, the figures being of cast iron. The pendulum is compensated, and the design has been made from a purely mechanical standpoint, so as to produce a reliable timekeeper. The booklet describes the mechanisms in detail, and illustrates the machine tools used in the clock's construction.

The clock is provided with the following bells: The second, third, fourth, seventh and tenor of a peal of eight, and the method of designing these is discussed, with the requirements for the striking mechanism.

BOILER AND FURNACE EFFICIENCIES.[1]

BY A. BEMENT.

It is not the object of this paper to treat of boiler and furnace efficiencies in general, but to discuss some features of the performance of modern standard apparatus. For this purpose two types of boilers, two furnaces and one stoker have been selected; one of the boilers, however, owing to changes made in it, may be considered as a third type. One of the boilers is twelve tubes high and sixteen wide, provided with a super-heater and rated at 400 horse-power. It is equipped with a chain-grate stoker of 65.5 square feet; the gases from the fire discharge among the tubes of the heating surface located immediately above, thence down across the tubes of the second pass and finally rise on the way to the flue across the tubes of a third pass. This boiler is referred to as boiler A. The other boilers are of two sizes. That designated as No. 1 is fifteen tubes high and nineteen wide. No. 2 is seventeen tubes high and nineteen wide. With each the gases travel from the bottom of the back and diagonally across the tubes to the upper front end, thence back between the drums to the flue. No. 3 adjoins No. 2 in battery, and is identical with it except that the path of the gases from the back end is forward among the lower tubes of the second to the seventh rows; thence to the front end of the boiler, then back among the next five rows and finally forward among the upper five rows, where they pass between the drums to the flue. In this arrangement the gases traverse the length of the tubes three times in place of the one diagonal travel of boilers Nos. 1 and 2. The furnaces under these boilers are identical, and each is fitted with a chain-grate stoker of 72.2 square feet. The tubes in the lower row of the boiler are entirely encircled with a firebrick tile from the front to a point back of the bridge wall; for the remainder of the distance to within four feet of the back end the usual tile furnished by the maker of the boilers is used.

[1] A paper read before the National Electric Light Association at its twenty-sixth convention, held at Chicago, Ill., May 26, 27 and 28, 1903.

The expression "boiler efficiency" is used to designate the performance of the boiler only, not that of the combined apparatus; it implies the measure of the cooling effect produced on the hot gases, and neglects radiation and moisture in the steam.

The experimental work herein mentioned had three objects: first, to determine the relative efficiency of boiler A and boiler No. 1, and second, the relation between the efficiency of the same boilers and their furnaces based on combustion and heat absorption, neglecting loss of combustible in the refuse. The two relative values to be determined were—for the furnaces, the loss due to escaping hydrocarbons and incomplete combustion, and for the boilers the cooling effect produced. With Nos. 2 and 3 it was desired to determine the relative cooling effect only.

TABLE A.

	BOILERS.			
	Boiler A.	No. 1.	No. 2.	No. 3.
Square feet of water-heating surface	4,000	4,340	4,800	4,800
Square feet of steam-heating surface	383			
Horse-power, standard rating	400	434	480	480
Horse-power, maker's rating	400	570	645	645
Horse-power developed	442.8	431.5	564.3	580.4
Horse-power developed above standard rating	10.7%		17.6%	20.9%
Horse-power developed below standard rating		.06%		
Horse-power developed below maker's rating		32.1%	14.3%	11.2%
Length of travel of gases in contact with tube-heating surface, feet	21	13	13.3	36
Temperature of escaping gases, F degrees	480.2	650.5	657	469
Temperature of escaping gases above saturated steam	127.8	273.1	278	92
Temperature of escaping gases above air supply	407.9	580.2	582	394
Temperature of saturated steam	352.4	377.4	379	377
Temperature of superheated steam	455.8			
CO_2	9.22	7.93	10.7	10.3

The efficiency of a boiler will be influenced by the initial or furnace temperature, and by the capacity at which it is worked. So as the horse-power increases the effect is to lower the efficiency, and as the initial temperature is lower, so is the heat transfer, and as a smaller boiler will absorb less heat than a large one, the determination of its efficiency according to some standard becomes a complicated problem. With the measure of performance of the combined boiler and furnace based on water evaporated from and at 212 degrees, a factor of evaporation has been devised to place different conditions on a common basis, but no factor, or set of factors, has as yet been devised to reduce various boiler performances to any standard of comparison. Therefore to determine the difference in efficiency be-

tween the boilers to be compared, requires in each case that the amount of heating surface, initial temperature, and amount of water evaporated, be the same; these requirements being met, it then becomes possible to discover the relative value of

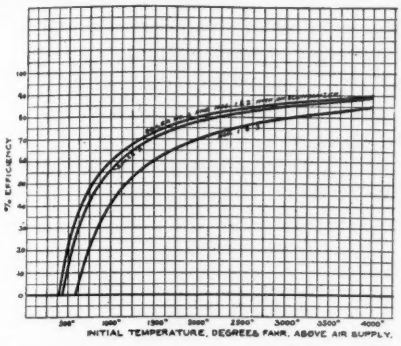


FIG. 1.—EFFICIENCY CURVE OF BOILERS NOS. 1, 2 AND 3, AND BOILER A.

the cooling effect produced. These requirements were very closely met in the comparative test between boilers A and No. 1, and also between Nos. 2 and 3. In fact, the performance of the four boilers is so nearly on the same basis as to be suitable for comparison.

Table A contains the essential data concerning the boiler trials.

Boilers A and No. 1 are practically of the same size, although the horse-power of the latter is rated by its makers 31.3 per cent above the former. The horse-power developed above that of No. 1 by boiler A is 10.76 per cent and its CO_2 is higher, but, owing to unburned volatile combustible equal to 8.79 per cent of the total combustible, the condition of com-

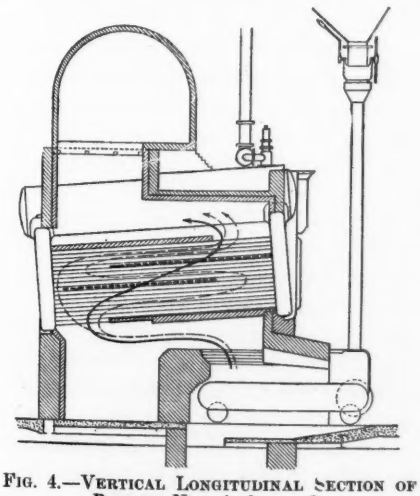


FIG. 4.—VERTICAL LONGITUDINAL SECTION OF BOILERS NOS. 1, 2 AND 3.

bustion is less favorable for this boiler than appears from the CO_2 measurement. The conditions for these two boilers may, therefore, be considered the same, except that with A, the saturated steam temperature was twenty-five degrees lower; for this reason its final temperature has been raised that amount, so that the comparison shall be on the same basis.

In the case of boilers Nos. 2 and 3 the combustion was complete. With No. 2 the air supply and horse-power were slightly less, giving it a small advantage over No. 3.

Conditions of operation being the same, the difference of cooling effect is shown by the difference in final temperature measured above that of the air supply; this referred to the initial temperature, also above that of the air supply, determines the efficiency of the boiler.

Fig. 1 illustrates the relative efficiency of the four boilers that are being considered. The initial temperature is shown through a range that covers all attainable conditions. From an inspection of the curves, it appears that the efficiencies of boilers Nos. 1 and 2 fall upon the same line, and that of A, which varied from

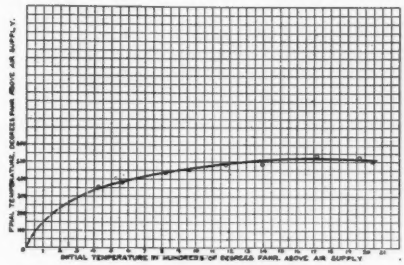


FIG. 2.—RELATIVE AND FINAL TO INITIAL TEMPERATURE, BOILER NO. 2.

the furnace temperature, is from about four per cent at 4,000 degrees to twenty per cent at 720 degrees above the efficiency of Nos. 1 and 2, while No. 3 is more efficient than that of A. If, however, it is assumed that Nos. 1 and 2 discharge their gases through an economizer that would reduce the temperature by 200 degrees, then the efficiency of the combined boilers and economizer will fall on the same line with that of the efficiency of No. 3 without an economizer.

The efficiency curves are based on the final temperature being constant through the full range of the initial. To what extent this is true is shown by Fig. 2, which illustrates the relation between initial and final temperature, the curve being plotted from simultaneous measurements. It appears that within usual working ranges the final temperature remains quite constant. The value of the relative efficiencies from the standpoint of fuel saving is quite important. It is shown in Fig. 3; the efficiency of boilers Nos. 1 and 2 being taken as the standard. The value of an efficient boiler when served by an inefficient furnace is forcibly illustrated.

The boiler and furnace of type A, having no special features, are not shown, but Fig. 4 is a vertical longitudinal section illustrating boilers Nos. 1, 2 and 3. The heavy arrow shows the path of the heated gases through Nos. 1 and 2. The travel in No. 3 is shown by the dotted

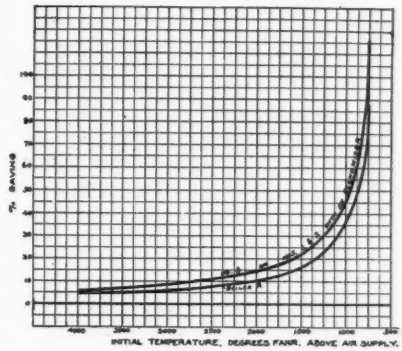


FIG. 3.—SAVINGS MADE OVER BOILERS NOS. 1 AND 2, BY BOILER A, AND BOILER NO. 3.

arrows. The two baffles added in this boiler are indicated by the horizontal dotted lines; the lower of these was located so that between its end and the back water leg there is a space of four inches left open for the full width of the boiler, to allow dust to drop down to the chamber below. Owing to this opening, the gas travel is split into two parts, a minor portion taking the more direct and shorter route by way of this opening, as shown by one of the dotted arrows, so, in fact, the effect on the hot gases of the three passes is not entirely secured. Fig. 5 illustrates a section of the tiles which encircle the lower row of tubes and provide a tile roof to the furnace extending beyond the bridge wall. The application of these tiles was devised by

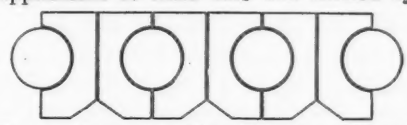


FIG. 5.—SECTION OF TILE ENCIRCLING LOWER ROW OF TUBES.

Mr. W. L. Abbott for reasons that will be discussed later. Fig. 6 shows the tiles which close the spaces between the lower row of tubes back of the encircling tiles. They are those regularly supplied by the maker of the boiler, and leave the lower half of the tube exposed to the passing hot gas and are usually known as the T-tile.

Inasmuch as there is a great difference in the cooling effect between the boilers compared, it will be interesting to study the reason therefor, and also to examine the drop in temperature of the gases on the way through the heating

surface. Regarding this latter phase of the matter, table B gives in detail the performance illustrated in Fig. 7, which is a curve of temperature drop through the surface of boiler A plotted from measurements taken during the trial. From this it appears that the same length of travel in the last pass gave only 6.7 per cent of the cooling effect of the first pass, illustrating the importance of the gases being in contact with the heating surface for as long a period as practicable if large cooling effect be secured. Figs. 8 to 11 show measurements taken among the tubes of boiler No. 2 and also apply to No. 1. Fig. 8 shows pervailing temperature among the tubes forty-five inches back from the water leg, from the bottom to the top of the boiler. The measurement at the first, or lowest, stay-bolt

TABLE B.

Temperature initial	2,012° F.	
" at end of first pass	908° "	
" at top of second pass	680° "	
" at bottom of third pass	555° "	
" at final	480.2 "	
Drop in temperature first pass	1,107° F.	72.064%
" " drums	158° "	10.29%
" " superheater	70° "	4.59%
" " second pass	125° "	8.16%
" " third pass	75° "	4.896%
Total	1,532° F.	100.000%
Horse-power developed in first pass	321	
" " in drums	44	
" " in superheater	20	
" " in second pass	35	
" " in third pass	22	
Total	442	

shows the effect of the heat from the tile roof immediately over the fire. The minimum temperature is between the second and third stay-bolts; above this it rises until at the point of escape the maximum is reached, showing that on the line of the measurements the highest temperature is at the point of exit. The drop of the ninth measurement is owing to the sudden change in the path of gas travel over the end of the baffle at the top of the boiler, which causes the hottest point to be carried back slightly more than forty-five inches at this ninth stay-bolt.

Fig. 9 is a curve from measurements taken through the ninth or top stay-bolt on a horizontal line, across and beyond the path of the gases at the exit from the tubes; the highest temperature is found at a point 46.5 inches back from the inside face of the water leg. From this point in each direction there is a rapid drop as the distance proceeds.

In Fig. 10 one of the curves shows the percentage of carbon dioxide in the gases on a line thirty inches inside and parallel with the front water leg of boiler No. 2. It will be observed that the measurements in the lowest part of the front of the boiler are extremely low; the first two, however, show the effect of leakage through the furnace roof. The contrast between boilers Nos. 2 and 3 in this respect is remarkable. An analysis showed the CO_2 to be low on account of the presence of air, it is proof that this air must have entered by leakage, and as such leakage could not be very large it follows that the path of the gases does not extend to the front lower corner of the boiler, or along close to the front water leg. This may be considered proven by the curve of CO_2 from boiler No. 3, subject to the same leakage, but with an arrangement of baffles which caused the flow of the gases to be carried into the front lower corner and nearer to the front water leg. It is further illustrated by Fig. 11, giving CO_2 measurements across the path of the gases at the exit from boiler No. 2, showing that the CO_2 increases with the distance away from the water leg. From measurements made through the back water leg of boilers Nos. 1 and 2, it is shown that a similar condition to that in the lower front corner existed in the upper back corner of the tube surface, but on a reduced scale, showing that with these boilers the back upper corner performs a small amount of work and the front lower corner still less, also that the active portion of the heating surface is on a diagonal line from the lower back to the front upper corners. It shows further that the volume of the moving gas body is of decreasing magnitude as it proceeds, and that as its centre is approached the temperature is higher, so it is probable that its centre is moving at a much higher velocity than its surface. According to Fig. 9 it would appear that the greater portion of gas was flowing through the space of one foot at the front end of the top baffle, and if an opening four feet long from the furnace at the lower back corner is large enough, it would follow that a space considerably less at the outlet would answer.

As the volume of the gases decreases rapidly with drop in temperature, it is probable that boiler A would be improved by passing the gases across it four times in passages of properly proportioned size, not adding to the amount of heating surface, but bringing more of it into active use; because with this boiler, as with Nos. 1 and 2, the tendency is for the gases to flow in a narrow path diagonally across the tube surface of the pass.

It is apparent that the greater efficiency of boiler A as compared with No. 1 is not owing to difference in amount of heating surface, but to greater length of travel of the gases in contact with the same amount of surface, or, in other words, greater length of time for the transfer of heat. This is still better illustrated by boilers Nos. 2 and 3.

The efficiency of the A type as compared with that of Nos. 1 and 2 is based on this particular type, which is a high "double-deck" apparatus, and it does not follow that a lower type would show such superiority. This may be illustrated by assuming that boilers A and No. 1 be each reduced one-half in height, when the effect would be that the length of the travel of the gases with A would be reduced fifty per cent, while with No. 1 the reduction would amount to less than ten per cent; so, as the height is less, the efficiency of A drops off very much faster, and while the gain in the high No. 2 over the low No. 1 type is small, with that of A it is very large.

The initial temperature, or, in other words, the condition of combustion, has more effect on the efficiency of the steam-generating apparatus than has the cooling effect of the boiler. This is shown by the efficiency curves Fig. 1, and if choice lay between the two, that of high initial temperature would be chosen; but high initial temperature is always dependent on skilful manipulation of the fire, and its attainment is difficult and more or less uncertain, while the superior boiler efficiency has a fixed value not dependent on the skill of the operator, and this value increases as the initial temperature decreases. There might be some question as to whether the full value of a good furnace would always be realized, but there could be no failure to realize the value of an efficient boiler.

The most remarkable feature of this matter of boiler efficiency is that the simple addition of inexpensive baffles,

with no labor cost for operation and requiring no additional room in the plant, gives results equal to an economizer requiring a large investment, considerable expense for maintenance, and a large amount of space for its installation.

The foregoing refers to the boilers only, and it is now in order to examine the furnace performance. The comparative test between A and No. 1 gave the

FIG. 6.—TILES CLOSING SPACES BETWEEN LOWER ROW OF TUBES BACK OF ENCIRCLING TILES.

following relation between the two apparatus:

	A.	No 1.
(1) Efficiency of combined boiler and furnace	57.83	59.12
(2) Efficiency of boiler	77.69	70.12
(3) Superior efficiency of boiler	7.57	
(4) " efficiency of furnace		8.86

Item 1 includes all losses except that of combustible in the refuse, all other losses except hot gases and combustion being the same for each apparatus.

Item 2 is the measure of the cooling effect produced by each boiler.

Item 3 is the difference in the cooling effect produced by the two boilers.

The superiority of the furnace under boiler No. 1, item 4, is owing to better combustion, there being a loss of 8.86 per cent with the furnace of the A boiler, due to escaping hydrocarbons and incomplete combustion, the air supply being considered the same in each case. The reason for the difference in combustion with these two furnaces will be understood when each is examined in detail. The furnace under the numbered boilers will hereafter be referred to as the tile-roof furnace, and the other as the A furnace; the former is shown in elevation by Fig. 4; the roof is made with tiles

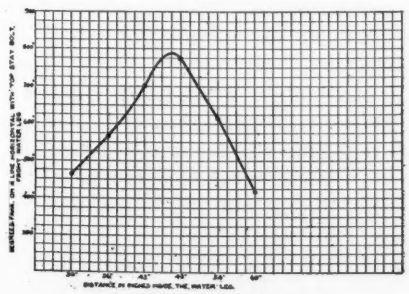


FIG. 9.—BOILER NO. 2.

shown by Figs. 5 and 6. The distance from the coal gate at the front of the furnace to the end of this tile roof is sixteen feet, a distance through which the gases must travel before coming in contact with the boiler surface except in the lower half of the bottom row of tubes, which for a distance of about four feet back of the bridge wall are exposed as shown by Fig. 6, there being a distance of travel of twelve feet with no cooling effect, except that of radiation from the exterior furnace walls and through the tile roof. During the interval of time that the gases are moving through this distance of sixteen feet their mixture is proceeding, so that before they have reached a point among the tubes where the temperature has dropped to a point below which union will be effected, the mixture is completed; or, as more generally understood, complete combustion is effected.

With the A furnace the gases from the fire rise immediately and pass among the tubes of the boiler. There being not to exceed three feet in distance for the gases to travel before the tubes of the boiler are reached, the temperature soon drops to a point at which chemical union does not

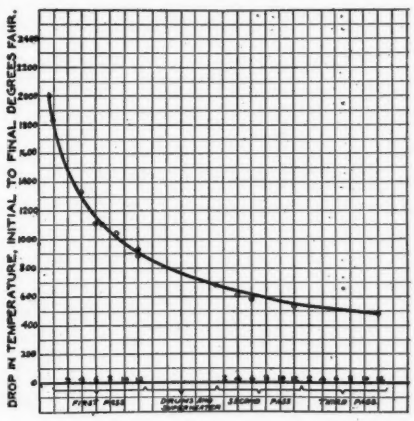


FIG. 7.—DROP IN GAS TEMPERATURE IN BOILER A OF 400 HORSE-POWER.

take place; the result is an escape of unoxidized combustible in the form of hydrocarbons, carbon monoxide and free carbon.

Fig. 12 is a reproduction of a photograph of a plant containing the tile-roof furnaces described, and also the A furnaces set under the A type of boilers. This was taken at a time when the plant was working at about its full rated capacity. The four tall chimneys serve twenty-four boilers of the type designated as Nos. 1 to 3, fitted with the tile-roof furnace, and equipped with chain-grate stokers of the A type, with a total grate area of 1,732 square feet, and with a total of 104,980 square feet of boiler-heating surface. The draught over the fire, measured in inches of water, ranges from 0.15 to 0.45. The shorter chimney on the right serves four A type boilers of a total heating surface of 20,000 square feet, equipped with chain-grate stokers having a total grate area of 306 square feet; the draught over the fire ranges from 0.20 to 0.25 in inches of water. The coal being burned at the time this photograph was taken, contains combustible matter that will average about 59.7 per cent fixed carbon and 40.3 volatile matter. It has a heating power of an average of 13,600

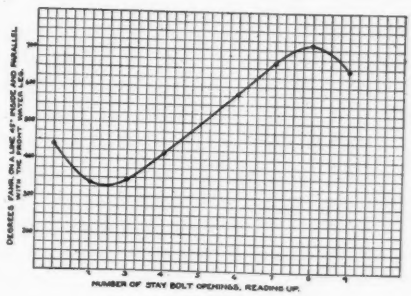


FIG. 8.—BOILER NO. 2.

B. T. U. per pound, and is what is considered the poorest coal that is mined in Illinois on an important scale; it is, however, the coal that gives the most heat from a money value in the Chicago market, and like all Illinois coal, will make much smoke when conditions are favorable. The appearance of the four chimneys which serve the tile-roof furnaces, compared with that of the others serving the A type, is evidence of the difference in action of the two kinds of furnaces.

The theory of the action of the tile-roof furnace may be given as follows: The coal entering at the front of the furnace has its volatile matter rapidly distilled in the form of a hydrocarbon gas in excess of the air supply at the front of the fire, and flowing back meets a larger air supply from the back of the fire, where the fuel bed is thinner. With this it mixes, the excess of air from the back satisfying the deficiency at the front; and being thoroughly mixed in the cham-

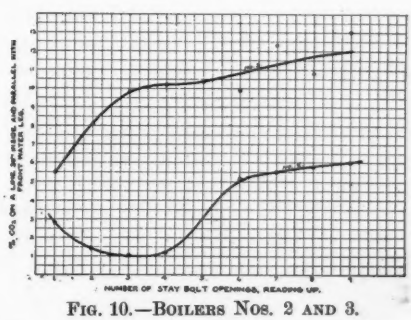


FIG. 10.—BOILERS NOS. 2 AND 3.

ber below the tile roof, it becomes, strictly speaking, a product of combustion at high temperature, which carries its heat from the furnace to the boiler. Assuming that the action of this furnace is as described, it would appear possible to obtain complete combustion with no air in

excess; the indications are that this is possible. With one of these furnaces carefully worked, and with the draught pressure at a certain determined intensity, it was possible to maintain an average as high as seventeen per cent CO_2, and for a few short intervals obtain as high as nineteen, according to the econometer connected to the furnace. There was no opportunity to test this condition with analysis, however, owing to the short duration of the intervals, but the econometer checked very closely with analysis at lower ranges. With the extremely small air supplies as given here, if the feed of coal was increased, it was accompanied by a rise in CO_2 to the apparent theoretical maximum, after which it fell, owing, presumably to carbon being oxidized to carbon monoxide, but there appeared to be no tendency for carbon to be set free.

With the A type chain-grate stoker and boiler, or similar boilers and furnaces, the gas distilled at the front of the fire flows directly among the tubes, and results in loss by unburned hydrocarbons and free carbon, the latter making smoke, while the large excess of air from the thinner back end of the fire also flows directly among the tubes, but at a different point, and there is but poor mixture. With such furnace, the smoke and loss of hydrocarbons will drop off with increased excess of air, owing to a stronger draught; but the loss from this increased excess of air is greater than the combustion gain, therefore best efficiencies are to be obtained with the smoky condition.

The above, concerning the three types of boilers and two kinds of furnaces under discussion, may be followed by an examination, as far as present knowledge will allow, of the single type of stoker that is to be considered. This is the chain-grate, and the one that is the nearest approach to an automatic machine; but in practice it is decidedly unsatisfactory as far as efficiency is concerned. The best performance secured with these stokers in the tile-roof furnace boilers is as follows:

	Example 1.	Example 2.
Efficiency	72.0	69.8
Pounds of water evaporated per hour per square foot of heating surface	4.1	6.07
Horse-power per square foot of grate	6.13	11.6

From these examples the efficiency has ranged down to forty per cent and capacity in proportion. The size of the coal used has an important effect on capacity—all other conditions being the same—and may affect the result as much as sixty to eighty per cent. The greatest fault thus far recognized in chain-grate stokers is the air leakage into the furnace at the back end of the grate. This and loss of combustible in the refuse are its major faults. With the grate as usually made and installed, an effort to prevent fuel being discharged over the back end by running short fires, is accompanied by an increase of the excess of air that often overbalances the fuel saving.

The entrance of air at the back end of the grate is, strictly speaking, a leakage; its entrance is by way of openings at the side of the stoker, between the top and bottom chain and under the traveling grate, and into the furnace by way of the opening between the bridge wall and the end of the grate. For this leakage at the back of the fire there are two remedies; one is to make the opening for the discharge of the refuse only large enough to allow the ash to pass out, and keep the end of the fire in contact with the bridge wall. This opening may be restricted by building the brick bridge wall the required distance above the grate, or by building into the point of the wall a metal box or pipe through which water circulates for the purpose of keeping it cool. The disadvantages of the brick wall are that the clinker readily adheres and makes trouble, and that the life of the brick at the lower edge is very short, requiring frequent and expensive renewal. The size of the opening is a matter that is necessarily unsatisfactory, because the amount of ash in the coal will differ and the opening must be large enough to accommodate the largest amount, consequently being too large when ash is low. The performance designated as example No. 1 was obtained with the brick wall described, and owing to an extremely large amount of ash in the coal the effect was to close the opening at the end of the grate largely with ash rather than with fuel, resulting in a comparatively small loss to the ash pit. Of these two means for keeping the air from leaking into the furnace by maintaining a joint between the end of the fire and the bridge wall, the water-back is the most satisfactory.

The other method of stopping air leakage at the end of the fire consists in closing the openings at the sides of the stoker frames, between the bottom chain and the floor under the stoker, and between the upper and lower chains. With this scheme the air leakage is avoided without keeping the fire against the bridge wall. It was with this method that the performance designated as example No. 2 was obtained; the large capacity was owing to the use of washed coal from the Wilmington district of Illinois. At the present time the best means to offer for the remedy of the faults at the back end of the fire is to seal off the leaks as mentioned in the second method, and the use of the water-back located as close to the grate as practicable. The latter performs an important office, inasmuch as it is an insurance against carelessness in running the fires over the back end of the grate.

The foregoing has treated only of the excess of air coming from the back end of the grate, but it does not entirely cover the subject of excess of air. With the furnace of the A type, twelve per cent CO_2 is about the maximum under any condition. This is also true of the tile-roof furnace unless the fire is so operated that a considerable excess of volatile combustible is evolved at the front end of the fire and mixed with the excessive air from the thin fire at the back. But the evolution of an excess of volatile combustible requires either a thick fuel bed or a low draught, and it appears that the thickness of fuel bed and strength of draught are features of importance.

With chain grates as generally installed and operated, all other conditions being the same, a reduction in the draught over the fire results in increased efficiency and reduced capacity. On the other hand an increase in draught over the fire increases the capacity but reduces the efficiency. In the plant mentioned as having the tile-roof furnaces, draughts over the fire range from 0.15 to 0.45 in inches of water, but the attainable depth of fire, height of coal in the hopper and speed at which the grate travels, are the same for each strength of draught. It is entirely reasonable to assume that if 0.15 is strong enough, 0.45 is too strong; likewise that if 0.45 is right 0.15 is too low; and it is apparent that the dimensions of the stokers and the various draughts are not in proportion to each other. In this plant the high efficiencies are always obtainable with the lowest draughts, and the highest capacities with the strongest draughts.

It is the general tendency to seek a strong draught over the fire with chain-grate stokers, and for this purpose induced mechanical draught apparatus and tall chimneys are employed; but suction draughts may be so strong as to cause such an excess of air to flow through the coal in the hopper as to prevent the fuel from igniting. It is possible that a moderate suction above and a pressure above atmosphere under the fire will give the most satisfactory results when large capacities are required.

Loss of combustible in the refuse with chain-grate stokers has been observed as

low as one per cent. With the tile-roof furnace, complete combustion with little or no excess of air has been secured, and if such desirable furnace conditions are combined with the performance of boiler No. 3, it will make an important improvement over the best prevailing practice. It is probable that this is the most efficient boiler of which there is any record. About the highest efficiency reported is that of a Thornycroft boiler by Professor Kennedy, showing 86.8 per cent of the heat absorbed when evaporating 1.24 pounds of water per square foot of heating surface per hour with a condition of combustion about the same as that with No. 3; under these conditions the gases left at forty-one degrees Fahrenheit above steam temperature. With, however, an evaporation of 3.2 pounds of water per square foot of heating surface and a somewhat better combustion, the gases left at 165 degrees Fahrenheit above steam temperature. In the case of boiler No. 3 the gases left at ninety-two degrees above steam temperature when evaporating 4.17 pounds of water per square foot of

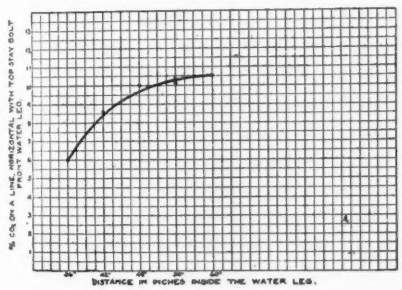


FIG. 11.—BOILER NO. 2.

heating surface. No. 3 is a more efficient boiler than A, but owing to its design, there is no favorable location for a superheater. With the A type, the design affords an excellent location, which is sufficiently removed from the excessive furnace temperature, and at a point where it is high enough to ensure the desired effect.

There is one feature of the tile-roof furnace previously mentioned, which is of considerable importance. It is the protection afforded to the lower row of tubes of the boilers designated as Nos. 1 to 3. It has been the maker's practice to use the tiles shown by Fig. 6. This leaves one-half of the bottom row of tubes exposed to the full furnace action; it does not matter that there are many hundreds of feet of surface in the boiler above, because the gases do not come in contact with this surface until after leaving the furnace. As with an economizer, the boiler is heated first. Applying this illustration to the surface exposed to the fire, the 110 square feet over the furnace may be assumed to be the boiler surface. This would mean that there are about 1.5 square feet of heating surface per square foot of grate; the result is that the tubes in the bottom row become blistered, bent out of line and fail, owing probably to

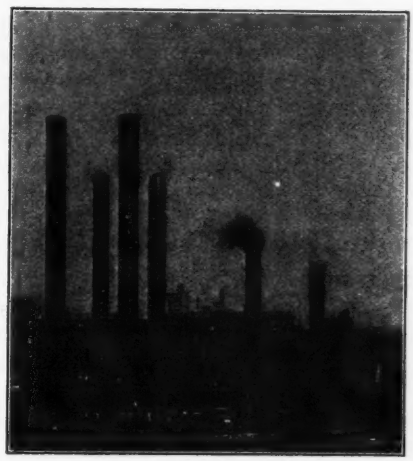


FIG. 12.—PLANT CONTAINING TILE ROOF FURNACES, ALSO A FURNACES SET UNDER A TYPE OF BOILERS.

the area of the tube not affording sufficient water supply. But with the tiles in place, the tubes in the lower row remain as straight and in as good condition as those in the uppermost row.

In concluding this paper, it will be interesting to make a comparison of the principal losses that occur with boilers and furnaces. For this purpose Figs. 13 and 14 have been prepared. These diagrams are designed to be pictorial illustrations showing the relations that these individual losses bear to each other, and would be best shown by one diagram if it were not for the complication of a large

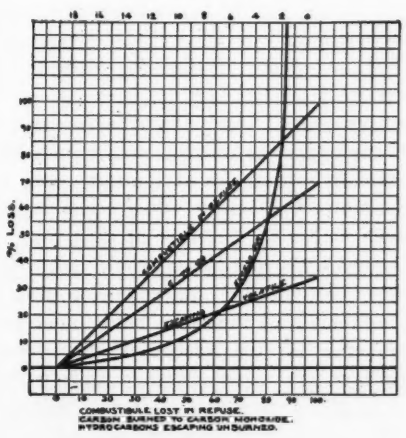


FIG. 14.

number of lines in one figure. For this reason the boiler loss is shown in Fig. 13 and that of the furnace in Fig. 14; with the former the performance of boiler No. 3 is selected to represent the loss owing to decreasing cooling effect with a very efficient boiler, and No. 2 for a much less efficient boiler. The zero of loss is taken at the steam temperature, because below this point no further cooling of the gases can take place; the range of capacity is carried up to the evaporation of twelve pounds of water per square foot of heating surface per hour, and the location of the lines is governed by the performance of the two boilers in the tests before mentioned. These two losses are represented as straight lines, which is not entirely correct, because as such they will intersect the line of 100 per cent loss if capacity be carried far enough, but a boiler could never be driven so hard that its efficiency would become zero. The representation by straight lines is sufficiently correct, however, for the purpose in hand.

Referring to Fig. 14, the losses owing to combustible in the refuse, carbon burned to carbon monoxide, and to escaping volatile combustible, are each carried to the theoretical maximum. It is, of course, impossible that all of the volatile matter could escape unburned; or that all of the carbon could be oxidized to carbon monoxide, as this is unattainable even in a gas producer. Neither

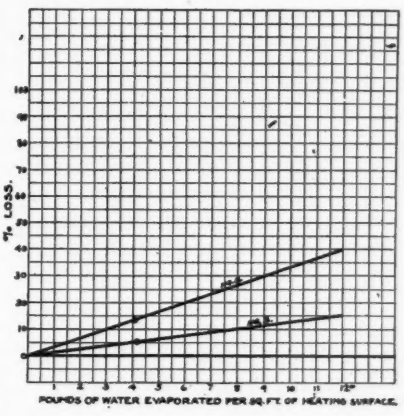


FIG. 13.—PRINCIPAL LOSS OWING TO BOILERS. DIFFERENT CAPACITIES. AIR IN EXCESS 85 PER CENT.

would it be possible for all of the combustible to be lost in the ash pit, because then there could be no fire. But it is useful to represent these three losses through this entire range for purpose of comparison with that owing to excess of air. The calculation of the loss of escaping volatile matter is based on Pittsburg coal. The curve of excess of air is based on a final temperature of 550 degrees Fahrenheit and a combustible of 14,000 B. T. U. per pound. As mentioned, the combustible losses can never be as high as 100 per cent, but the loss by excess of air can be as high as that, because with a small fire and large enough air supply, the initial temperature may be as low as that of the boiler. For this loss to be over 100 per cent, however, requires that stored heat from brickwork and furnace walls be given up to the air and gases in the furnace in addition to the heat from the fuel; such loss can exist for only a short time because the brickwork would soon become cooled. But that it is possible is proven by measurements showing a final temperature of 520 degrees with one per cent of CO_2.

Electrical Notes from Europe.

From Our Special Correspondent.

THE second international automobile congress is to be held in Paris from the fifteenth to the twentieth of June at the Automobile Club of France. The congress will hold a series of general meetings and conferences at which a number of interesting papers are to be presented relating to automobiles. Electrical questions both relating to electromobiles as well as the application of current in petrol motors will be brought out. A number of visits to different establishments at Paris will be one of the features as well as different tests which are to be carried out at the new laboratory of the club. On the fifteenth of June the following questions will be discussed, among others: Batteries and accumulators, catalytic action, coils of different kinds, spark-plugs, ignition by magnetos, dynamos, etc. On the following day the discussion will include the subject of motors, accumulators, electromobiles of different types, such as the petrol-electric, also petrol motors with electric transmitting devices. The congress will be officially closed on the eighteenth of June and will be followed on the nineteenth and twentieth by excursions and receptions.

A large hydraulic plant has been recently put in operation in Italy for electrochemical work. It is operated by the Volta Electrochemical Company, of Rome. The central station, which is located at Bussi, supplies current to a plant which produces caustic soda and chloride of lime by the electrolytic process. The electric outfit for the plant has been furnished by the Oerlikon Company. The hydraulic station at Bussi contains seven turbine groups of 450 horse-power each. The turbines are furnished by Picard & Pictet, of Geneva, and work at 450 revolutions per minute. They are direct-coupled to direct-current generators which give 180 volts and 1,500 amperes. The electrochemical factory is at a short distance from the hydraulic plant, and each generator supplies one of the electrolytic apparatus, of which six are now in operation. The remaining set furnishes power for six motors, ranging from 20 to 100 horse-power. The hydraulic station has also two sets of alternators, which are driven by turbines of 450 horse-power at 450 revolutions per minute. The alternators are of the Oerlikon triphase type and work at 6,000 volts and forty-five cycles. A high-tension line of nine miles runs from the station to Piano d'Orta, where is placed a switchboard to receive the main line, and it is divided here into two different circuits, one of which operates two non-synchronous motors of 220 horse-power each at 5,000 volts. The second branch supplies three reducing transformers of thirty kilowatts each for the low-tension circuits.

At the annual exhibition of the Société de Physique were to be seen several of the new apparatus for registering alternating-current waves. M. Hospitalier showed his new "ondograph," which is one of the most recent of these instruments and registers the wave upon a revolving drum. Another registering instrument, which works somewhat on the same principle, has been brought out by M. J. Carpentier, the well-known constructor, who also showed one of the latest forms of the Blondel oscillograph. The "ondograph" designed by M. Hospitalier uses the Joubert method of instantaneous contact combined with a device which sends a series of impulses into a condenser, which is then discharged into a galvanometer. In the Joubert method the momentary contact is made once every revolution of the armature and at the same point on the wave; this charges a condenser, which remains at a constant potential, as indicated by the galvanometer. In the present case a revolving contact device driven from a synchronous motor first makes the momentary contact to charge the condenser and next connects the latter with a galvanometer of the Deprez-D'Arsonval pattern. If the commutator revolves at the same rate as the motor the contact would occur at the same height on the wave at each revolution and the condenser would take the same charge; the galvanometer would thus remain at the same point under the influence of the successive discharges. However, the commutator is made to revolve at a somewhat slower rate than the motor, so that it loses one revolution in 1,000; this lag causes the contact to be made at a slightly different point on the wave at each revolution of the commutator and the condenser receives a succession of charges which rise and fall gradually. The galvanometer will not remain at the same point in this case, but the needle will travel from one side to the other and make a complete double swing during the 1,000 revolutions of the motor. The galvanometer needle carries a pen which moves over a drum which is operated from the motor by gearing, so that the to-and-fro motion is translated into a wave which is traced upon the paper, corresponding to the original wave-form. Three complete waves are registered during one revolution of the drum, which takes but half a minute. The method is therefore rapid and a permanent record of voltage or current waves can be obtained. M. Hospitalier has also made another form of instrument in which the galvanometer is replaced by a wattmeter and is thus able to register the power curves directly. This is a new feature and will no doubt be of considerable value. The Carpentier instrument uses somewhat the same principle for recording the waves, but the action is carried out in a different manner. The record is made by this method upon a flat strip of paper, which is introduced into a slot at the top of the case and comes out at the bottom. The galvanometer is mounted with the needle vertical in this case. The paper is moved under the pen by a toothed wheel on each side; the wheel is operated by an electromagnetic ratchet device which gives it a series of impulses causing it to revolve slowly and draw the paper with it. The instrument contains a discharge key which first makes contact with the condenser and then connects the latter with the galvanometer (replacing the revolving commutator); the key is worked at intervals from a synchronous motor by means of a cam on the shaft which carries a projection, and the latter strikes the key at each revolution. The lever of the key is not fixed, however, but is mounted on a circular plate which can be rotated, and while still turning it can be struck by the cam at any point. The circular plate is turned from the outside of the case by a handle. The same handle operates a commutator drum which sends a series of current impulses into the electromagnetic ratchet previously mentioned, for giving the movement to the paper, and the latter is run through a fixed distance for every revolution of the handle. In this way the movement of the paper coincides with that of the revolving plate which operates the key, and the curve drawn upon the paper will represent the variations of voltage in function of the time. The form of the wave is thus in-

dependent of the speed at which the handle is turned, seeing that the movement of the paper always keeps step with the progression of the contact point around the circle. The Carpentier exhibit also contained one of the new Blondel oscillographs (lately described in the ELECTRICAL REVIEW), which was shown in working order, representing the alternating-current waves upon a ground-glass screen. This instrument has the advantage that both the voltage and current waves can be seen at the same time in their relative positions. The waves are always visible so that varying phenomena can be followed. The waves can also be projected upon a screen in an enlarged form, and will thus be well adapted for lecture demonstration, especially for colleges. The instrument shown at the Société de Physique, which has thus been given a good working test, is to be sent to the Leland Stanford University. Several of the American colleges are now equipped with this instrument.

A project for an electric railroad in the south of Russia has lately been submitted to the government by the Crimean Railroad Company. It is proposed to build a railroad between Ialta and Bachtchisarai in the Crimea district. The system includes a main line and two branch roads. The main line is to be 45 miles long and will use narrow gauge of one metre. A part of the road, twenty-one miles long, has a very steep grade and it will be necessary to use the rack-and-pinion system over this portion; the remainder of the road will use the ordinary rail. The estimated cost of the main line, not including the branches, is $6,400,000. The current, which is to be taken from an overhead system, will be supplied from a hydraulic plant of 1,000 horse-power. An electric locomotive of 150 horse-power will be used, with passenger trains made up of three cars, as well as freight trains of five cars each. The trains are expected to make a speed of twenty miles an hour on level grade and seven miles an hour on the rack-and-pinion section. It is estimated that an annual traffic of 250,000 passengers and 5,000 tons of freight will be secured, and for this it is proposed to put four passenger and six freight trains in circulation per day in each direction. The distance between the terminal stations will be covered in four and one-half hours.

The magneto is now coming into use for producing the spark which is needed to ignite the gas in automobile motors. The magneto has some advantages over the use of the induction coil, as it does away with batteries and affords a device which is entirely mechanical. A number of different types have been lately brought out. One of these is the Deliège pattern, shown in the diagram, Fig. 1, in which the armature does not rotate in the field but merely swings back and forth. The field formed by the permanent mag-

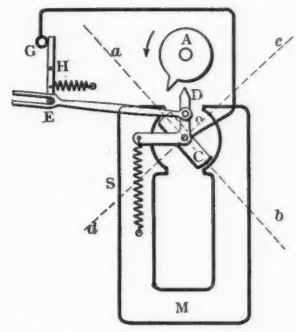


FIG. 1.—THE DELIEGE MAGNETO.

net M encloses an armature of the Siemens type C, which can turn about the central point O. Its movement is carried out by the lever D, which works against a spring S. The lever is operated from the motor by the cam A. When the projection of the cam strikes the lever it makes the armature swing from the position *a b* to that of *c d;* when the projection passes the lever the latter is quickly drawn back to the position *a b* by the spring S. This movement sets up a strong current in the armature, as its circuit is closed inside the motor cylinder through the spark contact. This contact takes place between the insulated projection G

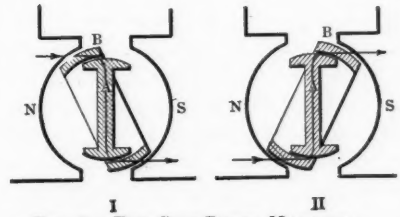


FIG. 2.—THE SIMS-BOSCH MAGNETO.

and the lever arm H, the latter being worked by a fork E which is also operated by the cam. During the passage of the armature to *c d* the circuit is closed at G H, but when it returns the fork strikes the lower end of the lever H and makes a quick break between G and H. This causes a spark to pass at the contact which unites the gas. The movement is regulated so that the break occurs at the position of maximum current in the coil.

The Sims-Bosch magneto illustrated in Fig. 2 uses a method of shifting the flux through the armature without moving the latter. The armature of the Siemens shuttle type is fixed at right angles between the pole-pieces and has a large air-gap, leaving space for an external iron piece which can partly revolve about the armature so as to occupy different positions with relation to the field. This cover is either revolved by the motor or simply oscillated back and forth by a set of levers. In the first position (I) the flux passes from one pole through the cover and down through the armature to the other pole, while in the second position (II) the flux is reversed through the armature. If the cover is rotated, each revolution corresponds to four reversals of the flux and thus it is not necessary to operate the moving parts at as high a speed as in the ordinary case, which is an advantage. One of the main advantages is the absence of moving contacts, seeing that the armature is fixed, and one wire can be connected to the mass of the motor and the other can be run directly to the spark-plug. The armature can be slightly adjusted about its centre so as to make the spark-break which occurs inside the motor to coincide with the point of maximum current in the armature.

The new electric locomotives which the Compagnie Industrie Electrique, of Geneva, proposes to use on the railroad running from Mure to Saint Georges de Commiers in the southeastern part of France are to employ the unusually high tension of 2,400 volts direct current. The third-wire system is to be used here with the 2,400 volts between the outer wires. The length of the line is twenty miles, narrow gauge, with maximum grades of 2.7 per cent; this grade is constant over a length of fifteen miles. At present the line uses twelve steam locomotives which are employed especially for hauling coal cars, with a load reaching fourteen to sixteen tons; and also twelve locomotives for passenger cars with thirty-seven tons maximum load. The company expects to replace the steam locomotives by electric locomotives. At present an electric locomotive furnished by Ganz & Company is being operated on this road, using the three-phase system. The new locomotives to be furnished by the Compagnie Industrie Electrique or the Thury system will soon be put in operation for trial, using 2,400 volts direct current. The locomotive has four motors which give a total of 375 kilowatts; the motors are always connected in series. For the three-

wire system the track-rail forms the neutral wire and the two overhead wires the outer conductors with the maximum difference of potential between them. Two rubbing contacts in the form of a bow pass over the wires. The series of four motors has its two terminals connected with the trolley contacts, and the middle point between the second and third motors is connected to the rail forming the neutral wire, through the body of the car. The maximum voltage between any one of the motors and the ground is not more than 1,200 volts, and each motor receives 600 volts at its terminals in normal working. As the present road is narrow gauge (one metre), the motors had to be reduced in size and therefore were required to run at a higher speed to give the same amount of power; accordingly the speed reduction is carried out by a double set of gearing.

Mr. Ed. Van Aubel has recently made a series of experiments at Paris relating to the action of radium and other bodies upon selenium. Himstedt and Bloch have already shown that the radiation from radium has an action upon selenium and causes its resistance to diminish as in the case of light or X-rays, but the action is slower. On the other hand, W. J. Russell showed that the peroxide of hydrogen acts strongly upon the photographic plate, and J. Sperber produced the same effect with turpentine. It has been found that the effect of the peroxide is due to a form of radiation which is analogous to cathode or Becquerel rays. The experimenter wished to find what would be the action of the rays of peroxide upon selenium. He placed a very sensitive selenium cell in the dark above a porcelain dish which contained peroxide of hydrogen in the proportion of thirty per cent. A brass plate one millimetre thick could be placed between the dish and the cell to cut off the action of the rays. The whole was then placed in a light-tight box. The selenium cell was balanced upon a Wheatstone bridge, and showed a resistance of 496,000 ohms when the brass plate was placed over the peroxide. On drawing off the plate and allowing the rays to fall on the selenium its resistance fell within three or four minutes to 324,000 ohms. On replacing the screen the resistance came back slowly to the original point. The same experiment was made with a porcelain dish containing turpentine and after fifteen minutes exposure the resistance fell from 461,000 to 386,000 ohms. The action of the turpentine is slower and the resistance also comes back more slowly. The distance from the active body to the selenium cell was in all cases three centimetres. The experiment shows that these radioactive bodies produce an effect upon selenium which is analogous to that of light, but that this action is much slower. It also shows clearly that certain bodies, such as peroxide of hydrogen and turpentine, give off a certain kind of radiation which is analogous to that of radium.

The municipal plant which has been lately erected at Wiesbaden-Schierstein for purifying water by means of ozone is one of the most successful applications of the system in practice. The ozone is produced by Siemens & Halske apparatus, which has a capacity of 250 cubic metres per hour. At present, however, the plant consumes but 125. The current is furnished by alternators and raised to high potential by a set of transformers. The high-tension current is sent into the ozonizers, which are supplied with a current of air, and the ozonized air is brought to the sterilizing towers where it is brought into contact with the water and thus purifies it. The plant contains two similar outfits of this kind, each of which has a separate alternator. The dynamo room contains two sixty-horse-power engines of the Wolf pattern, which operate two alternators and two direct-current machines. The alternating current is generated at 180 volts and is raised by a bank of transformers to 8,000 volts for the ozonizers. The current from the direct-current generators is used to operate two centrifugal pumps for the water supply, which are driven by electric motors, besides two pumps which supply air for the ozone apparatus. The plant is divided into three parts; the first of which contains the generating station, the second the ozonizers with their transformers, and the third the sterilizing towers. The ozonizing room contains forty-eight sets of ozone apparatus of the Siemens & Halske pattern, which consists essentially of a long metal cylinder surrounded by a glass tube through which the air is forced and receives the ozone. The cylinder is charged from one pole of the high-tension circuit and the other pole is connected to earth. The apparatus contains a number of such tubes which are placed in an outer tank and surrounded by water for cooling. The tank contains a glass window for observing the tubes and these have a bluish tint when in good working order. The pumps send the ozonized air to the sterilizing towers located in the third chamber. The towers are twelve feet high and are filled to a height of six feet with coarse gravel. A water-tank at the top of the tower allows the water to trickle down through the gravel and meet the ozonized air which comes up from below. The water falls through the perforated bottom into a basin from which the pumps take it to an upper reservoir. Each tower uses forty-two cubic metres of water per hour and at the same time eighty cubic metres of ozonized air. The water treated in this way is found to be quite free from noxious germs. The product from one unit or one-half the total plant is 125 cubic metres per hour. For this fifty horse-power is required, twenty-seven for the alternating current used in the ozonizers and twenty-two horse-power in direct current for the water pumps, with the rest for the air pumps.

C. L. DURAND.

Paris, May 30.

Electricity from Refuse.

The borough engineer of Fulham (England) has prepared a report on the working of the refuse destructor in conjunction with the electric lighting plant of that borough. About 30,000 tons of refuse were burned last year, leaving 16,000 tons of clinker which had to be disposed of. The report states that at least ten per cent of the weight of the clinker is due to the water used in cooling. The actual cost of cremation is eighty-six cents per ton, 30.12 cents of this being allowed for interest and repayment of loan. The expense for labor is 37.76 cents, and for shipping the refuse in barges, 7.4 cents. Repairs to the plant have cost 4.04 cents per ton, and the expenses for management were 2.88 cents. The report states that the life of the destructor will be less than thirty years, and advises that a depreciation fund be started. The borough has paid about fifty-six cents per ton toward the expense of cremation, and this leaves a deficit for the year of $7,860. In his report the engineer estimates the value of the destructor to the electrical station as a steam raiser. To do this, he credits the plant with the difference between the actual cost per unit for coal in Fulham, and the average cost per unit for coal in other districts having electric lighting plants owned by the local authorities. It is found that the average cost in seven other cases was 2.1 cents, whereas coal cost at Fulham 0.76 cent per unit. Multiplying the difference of 1.36 cents by the number of units, it is found that the refuse destructor saved the Fulham plant $11,300 last year. Assuming this estimate to be correct, the destructor is working at a profit of $3,440. The engineer also thinks that the cost of dealing with the clinker and other waste materials can be reduced.

STANDARD TRANSFORMER VOLTAGES.[1]

BY J. S. PECK.

That the advantages resulting from the use of standard apparatus are appreciated by both manufacturer and user, is shown by the continual efforts of the manufacturer to standardize his apparatus, and by a decreasing tendency on the part of the customer to call for special apparatus. The manufacturer of electrical apparatus has been handicapped in his efforts toward standardization by the rapid development of the electrical industry which has demanded modifications in old lines of apparatus to meet changing conditions, and the design and manufacture of new lines to meet new conditions.

With the older lines of apparatus, such as low-voltage generators and motors, and transformers for supplying motors and light, certain sizes and voltages have become generally recognized as standings, but in the case of transformers for high-voltage, long-distance transmission, the voltage requirements are still in a more or less chaotic condition, and even for low-voltage transformers, there are many customers who demand voltages just far enough from those usually required to necessitate new designs, new windings, etc.

In the early days of long-distance transmission, certain transformer capacities were selected as standard, but it was thought impossible to fix upon standard voltages for this service, as different voltages were required for raising and lowering transformers in order to compensate for line drop, and as no two lines had exactly the same length, and therefore the same drop, the same voltage was never required for two different plants. No standards had been proposed by the manufacturer, so that every customer or consulting engineer was at liberty to specify voltages to suit his own conditions without regard to those elsewhere in use. For this reason large numbers of transformers were built, which, though of the same size and same nominal voltage, were just far enough apart in voltage to be non-interchangeable.

In looking over a large number of transformer specifications, with a view to standardization, it was found that an allowance of more than ten per cent line drop was seldom necessary, also that there was a tendency among operators to specify certain nominal voltages, for example, 10,000, 15,000, 20,000, etc. It was therefore believed that if certain nominal voltages were wisely selected, and provision made in the transformer for varying them over a range of approximately ten per cent, standard voltage could be adopted which would fit practically all the conditions of service. The Westinghouse company therefore decided upon the following plan:

For standards, those voltages recommended by the American Institute of Electrical Engineers were chosen with such additions as were frequently demanded in commercial work. For varying these voltages over the desired range, the plan of bringing out taps from the winding was adopted. In the table are given the voltages which have been adopted as standard, as well as the variations which may be obtained. It will be noted that in all cases a value of five per cent below normal, and two values, one five per cent and one ten per cent, above normal may be obtained. There is thus obtainable from any transformer, a total range of fifteen per cent, which is found ample for almost every condition of service.

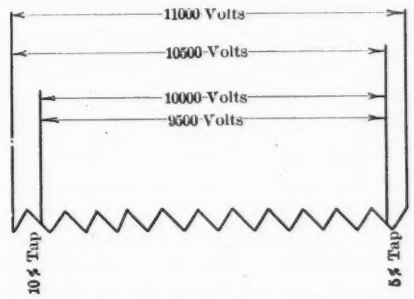


FIG. 1.—HIGH-TENSION WINDING, 10,000-VOLT TRANSFORMER.

In Fig. 1 is shown diagrammatically a 10,000-volt transformer winding with two taps brought out. The connections for the different voltages are clearly shown. This is the standard arrangement for all high-voltage transformers.

STANDARD HIGH-TENSION TRANSFORMER VOLTAGES.

Ten Per Cent Above Normal.	Five Per Cent Above Normal.	Normal.	Five Per Cent Below Normal.
2,200	2,100	2,000	1,900
3,300	3,150	3,000	2,850
5,500	5,250	5,000	4,750
6,600	6,300	6,000	5,700
11,000	10,500	10,000	9,500
16,500	15,750	15,000	14,250
22,000	21,000	20,000	19,000
33,000	31,500	30,000	28,500
44,000	42,000	40,000	38,000
55,000	52,500	50,000	47,500
66,000	63,000	60,000	57,000

It is frequently necessary to design the high-tension winding of transformers for series-multiple connections, the multiple connection giving one-half the voltage of the series connection. In such cases it is obviously more difficult to obtain the same range of voltage for each connection as is obtainable when a series connection alone is required. Where this series-multiple connection is demanded, the plan has been adopted of bringing out a tap from each half of the winding, so that five per cent of the total winding is included between each tap and the outside terminal. With this arrangement the multiple connection gives a voltage ten per cent in excess of the normal, and the series connection, two voltages, one five per cent and the other ten per cent in excess of the normal. The method of arranging the winding for these voltages is shown in Fig. 3.

Where the three-phase, two-phase connection is to be provided, each additional voltage means a large increase in the number of taps brought out, and therefore complication of terminal block. Where this connection is required, the transformer is provided with taps for increasing the normal voltage by ten per cent.

It is obvious that there may be other special requirements where the standard arrangements as outlined above can not be employed, but in the great majority of cases it is found that the arrangements proposed are eminently satisfactory.

STANDARD LOW-TENSION VOLTAGES.

The low-tension voltage of a transformer is determined by the character of the load which it is to supply, or, in the case of a step-up transformer, by the voltage of the generator from which it is supplied. It is obvious that, to meet all conditions of service, a large number of voltages will be required. Low-tension voltages may, however, be divided into a few fairly well defined classes, thus: 100, 200 and 400 volts for supplying light and motors, 1,000 and 2,000 volts for general distribution, and such voltages as are demanded for different classes of rotary converter work. To standardize low-tension voltages, the same plan was adopted as for the high-tension; *i. e.*, certain nominal values were selected and taps brought out for a suitable variation; for example, for a nominal voltage of 2,000, two taps are brought out so that the following voltages may be obtained: 2,200, 2,100, 2,000, 1,900. In many cases, however, low-tension windings must be arranged for series-multiple connection, so that two secondary voltages may be obtained, for example, 200 and 400 volts. For this condition, the same arrangement as was described for the high-tension is adopted; *i. e.*, a ten per cent tap is brought out from each half of the winding, as shown in Fig. 2. For the 200 to 400-volt combination, the following values may be obtained: 200, 220, 400, 420, 440. For

[1] A paper read at the twenty-sixth convention of the National Electric Light Association, Chicago, Ill., May 26, 27, 28.

rotary converters, the voltage required varies with the number of phases of the rotary, and with the direct-current voltage which it supplies. With transformers for this service, an alternating-current voltage is selected which will give the required direct-current voltage. This is considered the normal, and taps are brought out to give values approximately five per cent higher and five per cent and ten per cent lower than normal.

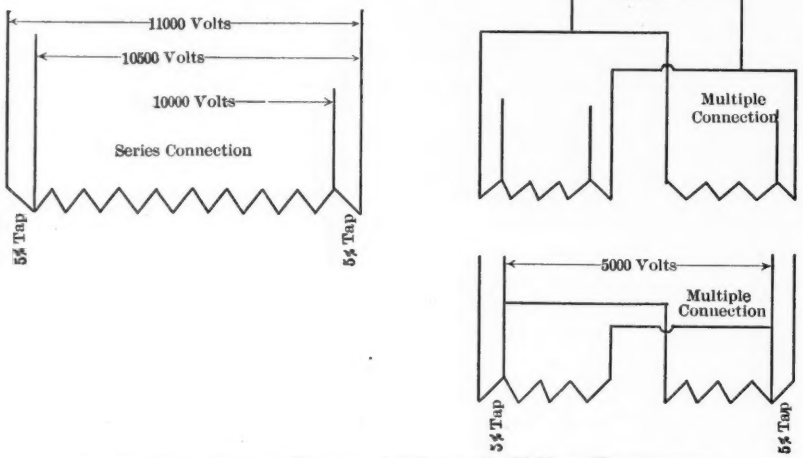


FIG. 2.—HIGH-TENSION WINDING, 5,000 AND 10,000-VOLT TRANSFORMER.

The following table shows the values adopted as standard for low-tension transformer voltages:

STANDARD LOW-TENSION TRANSFORMER VOLTAGES.

Service.	Normal Voltage.	Other Voltages Obtainable.
General Distribution.	6,000	3,700 6,300 6,600
" "	3,000	2,850 3,150 3,300
" "	2,000	.... 2,100 2,200
" "	1,000 & 2,000	1,100 2,100 2,200
Motors and Lights....	200 & 400	220 420 440
" " "	100 & 200	110 210 220

ROTARY 2ϕ

500 Volts D. C.....	365
550 " "	400
600 " "	435
650 " "	470

ROTARY 3ϕ

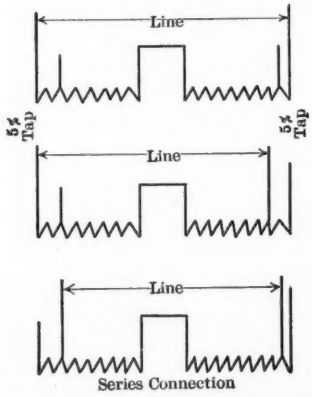
	One Higher and Two Lower Values in Steps of Approximation.
500 Volts D. C..... 315	5 per cent.
550 " " 345	"
600 " " 375	"
650 " " 410	"

It was stated that certain voltages had long been recognized as standard for small transformers used for supplying motors and lights. These voltages are nominally 1,000 to 2,000 on the high-tension side, and 50, 100, 200 and 400 on the low-tension side. There are, however, a large number of plants having transformers of special ratios, one of the most common being such as give secondary voltages, ten per cent higher than the usual values. On many long feeders the drop is so great as to make it impossible to obtain full lamp voltage at the end of such feeders, and here it is also desirable to have some means of obtaining higher secondary voltages.

For such work, it has heretofore been necessary to purchase transformers specially wound for the voltages required, but a certain type has recently been adopted for small transformers, a method by which not only the standard, but also special voltages may be obtained, thus greatly increasing the flexibility of the apparatus.

The high-tension winding of these transformers is wound in two parts, each for a nominal voltage of 1,000, thus giving 2,000 volts when the two parts are in series and 1,000 when in multiple. From each part a ten per cent tap is brought out as shown in Fig. 3.

With the parts connected in parallel for 1,000 volts, the whole of the winding may be used, giving, say, a 10 to 1 ratio; or by connecting to the taps, a 9 to 1 ratio, the latter connection boosting the secondary voltage ten per cent. With the two parts in series, the whole winding may be used, giving, say, a 10 to 1 ratio; or by connecting to the taps, five per cent or ten per cent may be cut out, thus giving ratios of 9½ and 9 to 1, respectively, the former connection boosting the secondary voltage five per cent and the latter ten per cent.



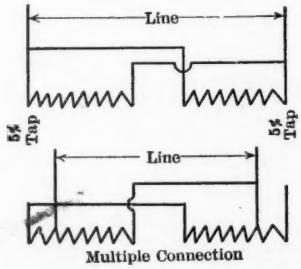


FIG. 3.—PRIMARY WINDING OF TRANSFORMER.

It is also of interest to note that these transformers are wound to give full output at three different secondary voltages—"Class 200" is arranged for 50, 100 and 200 volts, and "Class 400" for 100, 200 and 400 volts. These three secondary voltages taken in connection with the taps on the primary make an extremely flexible transformer and one which will give satisfactory service over a wide range of operating conditions.

The following table shows the nominal voltage rating of these transformers, also the ratio for the different connections:

PRIMARY.
"Class 200."

Voltage.	Ratio.
1,000.. 50-100-200 55-110-220	20, 10, 5 to 1 18, 9, 4.5 to 1
2,000.. 50-100-200 52.5-105-210 55-110-220	40, 20, 10 to 1 38, 19, 9.5 to 1 36, 18, 9 to 1

SECONDARY.
"Class 400."

Voltage.	Ratio.
1,000.. 100-200-400 110-220-440	10, 5, 2.5 to 1 9, 4.5, 2.25 to 1
2,000.. 100-200-400 105-210-420 110-220-440	20, 10, 5 to 1 19, 9.5, 4.75 to 1 18, 9, 4.5 to 1

The adoption of standard transformer voltages by one manufacturing company has been found thus far to give excellent results, and it is to be hoped that all the manufacturing companies may be able to unite upon certain standard values. The use of standard transformer voltages means to the manufacturer a reduced number of specifications, drawings and patterns, fewer chances of error, and

the possibility of manufacturing in large quantities—all of which tend toward a lower cost and quicker delivery.

The use of standard voltage transformers means that the user shares in the advantages gained by the manufacturer, and the possession of transformers which may be used interchangeably on different parts of his circuits is an advantage easily appreciated. It means to him the necessity of carrying in stock fewer spare parts and the possibility of obtaining such parts much more quickly than when special ones are required. It means the ability to shift the apparatus from one part of his system to another, and in general a great increase in the flexibility of a vital part of his equipment.

With large transformers, the volts per turn often reach a comparatively high value, and as taps can not be brought out at less than one-turn intervals, it is often impossible on low voltages to obtain steps of just the right percentage. In such cases the transformers are designed to give the correct normal voltage, and the taps are spaced to give values as near as possible to those desired.

The American Society of Mechanical Engineers.

The forty-seventh meeting of the American Society of Mechanical Engineers will be held at Saratoga, N. Y., June 23 to June 26, 1903. The professional sessions will be held on the second floor of the United States Hotel, which will be the headquarters of the association for this time. The opening session will be held on Tuesday evening, June 23, at 8.30 P. M., in the ballroom of the United States Hotel. The address of welcome will be made by Mr. Albert L. Rohrer, chairman of the local committee, with the response by Mr. James M. Dodge, president of the society.

The following papers will be read at this time: "United States Army Gun Factory at Watervliet Arsenal, New York," J. M. B. Scheele; "Test of Hydraulic Elevator Plant," R. P. Bolton; "Rational Train Resistance Formula," John B. Blood.

After this meeting an informal reception will be held for the members, visitors and ladies in the ballroom.

The second session will be held on Wednesday, June 24, at 10 A. M. This will be the business session for the report of tellers and committees, discussion of proposed constitution, by-laws and rules, as per the report of the committee on revision of the rules and methods, and general business. After the executive business has been concluded, the following papers will be read: "Turbine Flow Recorder," Charles M. Allen; "Some Data on Hoisting Hooks," John L. Bacon; "Strains Produced by the Excessive Tightening of Nuts," A. Bement.

During the morning business sessions there will be walks and drives for the ladies to various places of interest in and about the city, excursions by trolley to Kaydeross Park, on Saratoga Lake, and to other points.

The third session will be held on Wednesday, June 24, at 2.30 P. M. Papers will be read as follows: "Indicating Anglemeter," C. E. Sargent; "Recent Practice in Forcing, Shrinking, Driving and Running Fits and Limits for Limit Gauges," Stanley H. Moore; "Graphical Daily Balances in Manufacture," H. L. Gantt; "Shop Management," Fred W. Taylor; "Steam Turbine from Operating Standpoint," F. A. Waldron.

On Wednesday evening, at 8.30, there will be an informal entertainment, the members and visitors being entertained by the Jest and Song Club, of Schenectady, N. Y.

The fourth session will be held on Thursday, June 25, at 9.30 A. M. The following papers will be read: "Experiment Boiler of Ohio State University," E. A. Hitchcock; "Curves of Water Consumption for Various Horse-Powers of Several Engines," J. S. Jacobus; "Drawing Office Equipment," J. McGeorge; "Bursting of Emery Wheels," C. H. Benjamin.

The following excursions have been arranged for Thursday afternoon, June 25: At 1.30 P. M., leave Saratoga by train for Mechanicville, Duncan Paper Mill, and Hudson River Power Company's station; Watervliet Arsenal, and Cluett, Peabody & Company's factory at Troy; Albany filtration plant; Albany Capitol, City Hall and Park; leave by train for Speirs Falls, new plant of Hudson River Power Company; leave by D. & H. R. R. for Sandy Hill, to visit the new sulphite mill in the Union Bag and Paper Company's plant.

On Thursday evening, at 9.30, there will be a reception of the members and guests by the president of the society and officers of the local committee.

On Friday morning, June 26, at ten o'clock, the society will be the guests of the American Locomotive Company and the General Electric Company, on an excursion to Schenectady.

The fifth session will be held on Friday, June 26, at 1 P. M., in the Union College Chapel, Schenectady, N. Y. The following papers will be read: "A Sixty-Foot Boring Mill," John Riddell; "Alternating-Current Motors for Variable Speed," Walter I. Slichter; "Positive Governor Drives," A. H. Eldredge.

At 2.45 P. M. the party will go by trolley cars to the General Electric Company's shops.

The closing session will be held on Friday, June 26, at 8.30 P. M., when the following papers will be read: "Test with a Twelve-Horse-Power Gas Engine," C. H. Robertson; "Internal Combustion Engine Using Kerosene as Fuel," H. F. Halladay and G. O. Hodge; "Gas Engine Testing," E. C. Oliver; "Mechanics of Air-Brake Systems," H. G. Manning; "Hot Well as Oil Extractor," A. H. Eldredge; "Comparative Oil Tests," W. F. Parrish; "Test of Eight-Foot Fan Blower," E. S. Farwell.

The annual meeting in December will be held in New York city.

The officers of the general local committee of the Saratoga meeting are A. L. Rohrer, chairman; H. G. Reist, secretary; H. G. Hammett, treasurer. The society officials are James M. Dodge, president; William H. Wiley, treasurer; F. R. Hutton, secretary; Francis W. Hoadley, assistant to secretary and treasurer; Louis A. Gillet, assistant to secretary, and C. A. Morrison, official stenographer.

Important Air-Brake Experiments Abroad.

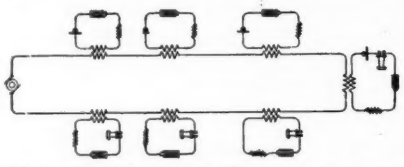
Another experiment with the Westinghouse air brake has been made in England, for the purpose of solving the problem of controlling freight trains traveling at high speeds on steep descending grades. The North-Eastern Railway Company recently conducted a series of important trials on its lines, which at one point attains an elevation of 1,800 feet above sea level, and is one of the steepest sections of railway in the United Kingdom.

Forty heavy coal cars comprised the train, each car being equipped with Westinghouse rapid-acting brake apparatus, the air pressure being operated from the engine. Despite high speed, unfavorable climatic conditions and traveling on the down grade, the train was brought to a stand in a very short distance, the application of power on both front and rear wheels of the train being practically simultaneous.

The trials were conducted under the supervision of the leading officers of the North-Eastern Railway and representatives of the Westinghouse Brake Company, and are said to have been highly satisfactory.

Electrical Patents.

Mr. John Stone Stone, of Cambridge, Mass., has just obtained a patent on a novel method of electrical distribution and selective distribution. The invention comprises methods of electrical selection, analysis and distribution. By means of these methods vibratory electromotive forces or electric currents of different frequencies or rates of vibration simultaneously impressed upon an electric circuit may be individualized and selectively utilized, regulated, absorbed or distributed. The invention, its results and objects are founded upon certain electrical phenomena which closely resemble those known as resonance in acoustics. As an acoustical resonator may be so designed as to respond but feebly to all sound vibrations except such as correspond to a given and predetermined critical pitch or rate of oscillation, so an electric circuit may be proportioned in such a way that its responses to all harmonic electric vibrations except those of a given critical frequency or rate of oscillation will also be extremely feeble. When an harmonically vibratory electromotive force is impressed upon such a circuit (which for convenience may be called a "resonator circuit"), everything else remaining the same, the resulting current in such circuit depends on the frequency, for there is a critical frequency at which the said current is at a maximum, and any change in the frequency from this point in either direction produces a decreased resulting current. This property of resonance depends upon the simultaneous presence in the circuit of electrostatic and electromagnetic capacity, and in order that an electric circuit may have appreciable resonance it is requisite that it possesses sufficient electrostatic and electromagnetic capacity to hold in the form of electrification and electromagnetism an appreciable amount of electrical energy supplied to it. In the proposed new system Mr. Stone effects the distribution and regulation of a plurality of vibratory electric currents impressed upon a main circuit by associating with such main circuit a plurality of resonator circuits of the character and constitution indicated, each organized and proportioned to select that particular current of the series to which it is responsible or under which it becomes operative. By suitably proportioning the capacities, inductances and resistances of these resonator circuits, he is able to make them individually responsive to impressed electromotive forces of any desired frequency or rate of vibration. The impedance presented by such circuits to the passage of alternating currents depends upon the frequency of said currents, it being lowest when the said frequency is or is approximately that to which the resonator circuit is designed to respond, and it increases rapidly as the frequency is increased or decreased from that value. In the operation of the system each resonator circuit selects from the electromotive forces impressed upon the main circuit that particular one to which it is designed to respond, and a current is developed thereby in any given resonator circuit, which current is not materially or appreciably interfered with by the currents produced in any of the other circuits. The invention may be utilized by several methods. It may, for example, be used for the purposes of individual or selective signaling or multiplex telegraphy, and to that end signal-receiving

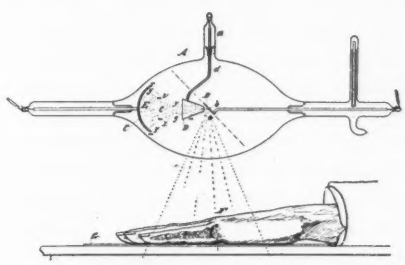


METHOD OF ELECTRICAL DISTRIBUTION AND SELECTIVE DISTRIBUTION.

apparatus is placed in each of the groups of resonator circuits, and currents of different frequencies are employed. The signals are sent and are received on the apparatus of the resonator circuits, respectively, either simultaneously or not, without mutual interference. The invention is not, however, restricted to distribution, telegraphy or selective signaling in one direction only, but is also adapted to reciprocal transmission between a terminal station and a series of way stations or between any two stations located at any points on a main circuit. If for selective signaling, multiplex telegraphy or other useful purposes it be desired to regulate individually, vary and absorb alternating currents of different frequencies simultaneously impressed upon a main or signaling circuit, it may be accomplished by associating one or more resonator circuits with said main circuit, which when their resistance, capacity or inductance is altered, will selectively react on the several currents, varying, regulating and absorbing them, and, if desired, such changes effectuated in one of two or more similarly proportioned resonator circuits may produce signals corresponding to such changes in connection with the remainder of such similar circuits. Thus far a number of impressed vibratory electromotive forces of different frequencies have been referred to; but such an arrangement is not essential, for a single vibratory electromotive force, provided it is not of a simple harmonic character, may be impressed upon a circuit in a manner well understood and is capable of exciting currents of different frequencies, respectively, in several resonator circuits, just as a compound tone is capable of exciting the sonorousness of several acoustical resonators attuned to the different pitches composing the said tone. We may consider a vibratory electromotive force which is not of a single harmonic character as a compound of the several harmonic electromotive-force vibrations, which when summed will produce the same form of wave. In this invention, therefore, it is not necessary that for the operation of each associated resonator circuit there shall be impressed a separate vibratory electromotive force, and where it is more convenient a compound vibratory electromotive force (by which is meant one capable of being resolved or analyzed into a plurality of simple harmonic components) may be used.

When an electric current begins to pass from the anode to the cathode of an X-ray tube, particles of gas in contact with the negative concave cathode become charged with negative electricity, and hence are repelled from said cathode in straight lines at right angles thereto and form said cathode stream, which tends to approach the focal centre of said cathode and becomes concentrated; but as these particles are negative and repel each other, each particle is deflected from what would otherwise be a straight course to said focal centre, and moves in a resulting curve ending at the anode. During the use of said tube the number of particles of gas in the tube that enters into circulation to form the cathode stream varies and depends upon the relative individual charges of the particles or the amount of electric current sent through the tube, and thus determines the volume and diameter of the cathode stream. These variations in the cathode stream cause the variations in the size and position of the area of bombardment on the anode. It is these changes in said area of bombardment that affect the clearness of definition of the body radiographed on a photographic plate, said body and said plate being in fixed positions relatively to the anode. Mr. John O. Heinze, Jr., of Chelsea, Mass., has devised an improve-

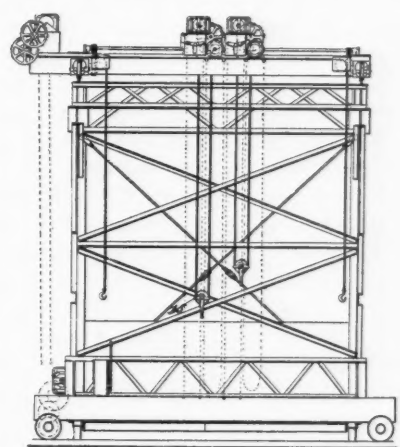
ment whereby the cathode stream can be so controlled that it has an area of bombardment of the smallest possible diameter and moreover has a fixed position on the anode. The structure will be clearly apparent by reference to the accompanying illustration. A is an X-ray tube; B, its anode; C, its cathode; *c*, the focal centre of said cathode, and D a funnel, preferably of metal, such as platinum. E is a cathode stream, while *x x* are any two particles of gas in said stream moving in paths *y y* from the cathode to the anode. The funnel D lies between the cathode C and anode B and is insulated therefrom. It is held in position by a support *d*, mounted in a glass-supporting arm *a*, blown into the tube. The longitudinal axis of said funnel coincides with the axis of the cathode and anode. The inlet orifice of said funnel is adjacent to the cathode and is of sufficient size to allow the whole of the cathode stream E



X-RAY TUBE.

to flow into it freely, and its small discharge orifice is in close proximity to the anode B. F, the object to be radiographed, is shown as a hand resting upon a photographic negative G. The operation is as follows: An electric current is caused in the well-known manner to pass from the positive anode B to the cathode C, which immediately becomes negative. The gas particles, as *x x*, in contact with the cathode become negative and are driven toward the focal centre *c;* but as they are negative they repel each other, and hence their resultant directions are in curved paths *y y*, leading toward the anode B. These particles, with all that join to form the cathode stream E, enter the large orifice of the funnel D. The latter being metal, it becomes negatively charged by the bombardment of its walls by some of the moving negative particles and remains so charged during the flow of the cathode stream. As the funnel is negatively charged, it tends to drive away from it the negative particles, and with its converging interior surface thus concentrates said cathode stream more and more, so that when the latter leaves the outlet orifice and strikes the positive anode at *b* it is of very small diameter. The area of bombardment *b* is therefore very small, and as the funnel D and the anode B are in fixed positions the area of bombardment is fixed. The area of bombardment being small and constant, and said area, the object F, to be radiographed, and the photographic negative G all being in positions fixed relatively to each other, the details of the object F will be sharply defined upon the negative F, and all the objections arising from an area of bombardment that varies either in diameter or in its position upon the anode, or in both, will be obviated and the objects of the invention obtained.

The American Car and Foundry Company, of St. Louis, Mo., has purchased from Mr. Joseph H. Ames, of that city, a patent granted to Mr. Ames on an erecting-crane, designed especially for use in the erection of steel railway cars. The aim of the inventor is to provide an electric crane that will handle to advantage the different parts of the car or the riveting machines that work on the car. The crane is mounted upon a truck or platform designed to be operated over a track, the gauge of which track is made as wide as possible, so that the wheels on the side opposite the masts will bear on the rail and oppose the tendency of the structure to overturn by reason of the long overhang of the jibs. There are two masts extending upwardly from the truck, from which project stationary jibs or beams in a horizontal direction. These jibs carry a traveling bridge-crane of the ordinary type. The truck is provided with an electric motor, which is geared to one of its axles, whereby the entire structure may be moved along the track in either direction, at the will of the operator. Counter-balance weights are placed on the truck between the masts to counteract the tendency of the structure to overturn by reason of the weight of the crane-bridge and its load when at the extreme outer end of the jibs. On the upper faces of the jibs are suitable rails on which the wheels of the movable bridge run. This bridge is of the ordinary crane type, and the movement in this case is effected by a pendent hand-chain passing over a sprocket-wheel, which in turn is located on a shaft running the full length of the bridge, and the movement of this shaft, by pulling on the chain, is communicated to the truck-wheels of the bridge by means of a suitable pinion and gear-wheel on the truck-wheel axle. Upon the traveling bridge-crane are mounted two trolleys, each being equipped with an electric motor and a drum for reeling up the wire rope by means of which the load—such, for instance, as a hydraulic or pneumatic riveter—is hoisted, the power of the motor being communicated to the drum through a suitable train of gears. The motor is operated by a suitable controller, which is operated from the floor by means of pendent hand-chains. The bridge-crane is so constructed that one end extends beyond and overhangs one of the jibs in order to permit the placing thereon of a relatively stationary motor-driven hoisting-drum without interfering with the travel of the movable trolleys. This hoisting-drum is designed to reel up two independent wire ropes, which leave the drum in a horizontal plane, pass over sheaves which are attached to the side of the bridge-crane, one being near each end, and thence in a vertical plane toward the floor. The function of this hoist is to



ERECTING-CRANE.

enable the operator to attach the ropes to parts of the car or other structure which may be lying on the floor and which he desires to lift, move to the desired position, and hold securely while the necessary bolting is done preparatory to the riveting operation. The motor of this hoist is operated through a controller having pendent hand-chains similar to those on the trolley. The conductors supplying electric current to the crane are preferably located between the rails on which the crane runs, and the collector is attached to the bottom of the truck and extends downward to make contact with the conductors in a manner similar to the well-known third-rail system for electric railways. The hydraulic or pneumatic power for the riveting machines may be conveyed to same by means of swivel-jointed piping or hose.

Reviews of Current Engineering and Scientific Literature.

The Debut of the Alternating-Current Transformer.

This short article by M. E. Guarini describes what are stated to be the first industrial alternating-current transformers ever constructed. These transformers were designed by Lucien Gualard, and installed in the town of Tivoli, Italy, sixteen years ago. Three types of transformer were used, the smallest having a capacity of 150 watts, delivering at the terminals of the secondary a current of three amperes at fifty volts. The medium type had a capacity of 600 watts, and gave six amperes at 100 volts. The capacity of the largest size was 1,800 watts, giving thirty-six amperes at fifty volts. Only the medium and small types now remain. The transformers were placed in the heads of the fifty-candle-power lamps used for public lighting, and were operated in series. For two twenty-candle-power lamps one 150-watt transformer was used, lodged on the wall of a building. The wiring was all bare conductors, the voltage being 2,000. These transformers have recently been removed, owing to an extension of the works of the electric lighting company of Tivoli. It is proposed that a memorial be raised to commemorate this early system of the distribution of electrical energy by the aid of transformers—*Abstracted from the Electrical Review (London), May 22.*

Electricity in the French Slate Quarries.

This article first describes the method of mining the important slate quarries of France, and then gives particulars of an electrical installation recently installed at one of these. There were a number of troublesome problems to be solved, one of these being the bad quality of the water, which was not only too acid to be used in the boilers, but attacked the insulating covering of the cables. There is one 150-horse-power condensing De Laval steam turbine, driving two three-phase alternators, and, through gearing, the exciter. The turbine operates either exhausting into the air, or with a condenser. The alternators are of the inductor type, with a special compound field, maintaining a constant pressure independent of the load. This compound current is supplied from a regulating series transformer. The magnetic field of the exciting current is a polyphase field, revolving at a given speed, and developing at the collector of the exciter armature a continuous current which is supplied to the alternator field. Both the cores of the field and the stator of the exciter are laminated, and the number of turns of the coils of the Gramme ring armature vary according to the sine law. This exciting dynamo supplies thirty-five amperes at seventy volts continuous current, taking from the alternator 120-volt, three-phase current. Owing to the compounding of the generators, the switchboard contains no regulating rheostats, although there are two alternators working in parallel. This station supplies all the lighting of the quarry, operates the electric hoisting machinery, and also the winches underground. The motors contain two stators, which act on the two parts of a rotor, these having a common squirrel-cage winding. The drills in the mine are worked by compressed air, but the pumps and elevators are driven electrically.—*Abstracted from Engineering (London), May 22.*

New Electric Works at Worcester.

The city of Worcester, England, has had an electric lighting system since 1894, operated partially by water power. As the use of electricity extended, this plant had been enlarged until the conditions became such that it was thought advisable to erect a second power-house, rather than add further to the first. The new power-house is operated entirely by steam, and does not differ materially from the usual English practice. The engine room contains two 250-kilowatt Belliss-Bruce-Peebles generating sets, consisting of two large Belliss engines driving single generators delivering current at 260 volts for the three-wire lighting system, or at 250 volts for the electric railway. There is also a third Belliss engine of the same capacity, connected to two 125-kilowatt Bruce-Peebles dynamos, which may be used as balancers for the three-wire system. There is, in addition, a motor-generator set consisting of a seventy-five-kilowatt motor-alternator and a 120-horse-power Belliss engine. The latter set serves two purposes: When the old power station is shut down from floods or low water, the alternator of this group furnishes power for the lighting from the old station. When, on the other hand, there is an excess of water at the old station, the alternator is run as a synchronous motor, and drives the direct-current generator coupled to it. Tests of the large engines showed that the steam consumption at full load was 20.36 pounds per kilowatt-hour, with a boiler pressure of 175 pounds and a steam temperature of 499.8 degrees Fahrenheit. At half load the consumption was 22.6 pounds, with the same boiler pressure and a steam temperature of 438 degrees Fahrenheit. At one-quarter load it was 27.1 pounds of steam per kilowatt-hour, at the same boiler pressure, and with a steam temperature of 406 degrees Fahrenheit. The station has a storage battery consisting of 250 cells, with a discharge of 630 ampere-hours at a rate of 105 amperes. A booster is provided for charging this battery. The switchboard is of the well-known Ferranti type, special precautions being taken to make the switch gear fireproof. No wood whatever is used. The boiler house contains three Babcock & Wilcox boilers, each capable of evaporating 11,000 pounds of steam per hour. They are each fitted with chain grate stokers, a Green fuel economizer has been provided, and there are two steam-driven feed pumps and two motor-driven centrifugal pumps. The feeders of the system are double concentric lead-covered cables, laid solid in earthenware troughs, filled in with pitch. The corporation of Worcester is under contract to supply the local tramway company with power. This road is not yet in operation.—*Abstracted from the Electrician (London), May 22.*

The Electromotive Force of the Daniel Cell.

Although a study of the electromotive force of the Daniel cell is not of much interest to-day, as there is apparently no need for a closed circuit standard, still this contribution by Herr Ernest Cohen and J. W. Commelin is valuable because of the satisfactory agreement between results of various tests, and because they seem to disprove the apparent failure of Nernst's law when applied to this cell, as stated by Chaudier. These tests were made upon a special type of cell, and great care was taken to maintain the entire cell at a constant temperature. The cell consisted of three test tubes, connected together by glass tubing. The

first tube contained a saturated solution of copper sulphate. Within the tube connecting this test tube to the second of the series was placed a stop-cock filled with cotton wool. The second glass tube contained zinc sulphate of various densities, and the last contained the zinc sulphate and the zinc amalgam. Connection was made with the zinc amalgam by means of platinum wire carried through the glass tube. The copper electrode was a piece of copper wire passed into the cell through a glass tube. This was always freshly plated before being used. The whole cell was immersed in a calorimeter, and sufficient time allowed for it to come to the standard temperature of fifteen degrees centigrade. When a test was to be made, a glass rod was passed into the calorimeter, and by means of this the stop-cock was opened. After a reading had been obtained this was closed. The cotton wool and the intermediate test tube avoided all possibility of the copper sulphate reaching the zinc electrode. Determinations were made by means of a Poggendorff potentiometer, and comparisons made with both standard Clark and Weston cells. The concentration of the zinc sulphate solution varied from one-twelfth of one per cent to saturation. The electromotive force decreased regularly with an increase in the concentration, the mean value of the several tests being 1.146 volts for the most dilute solution, and 1.081 for the saturated solution, and the results show full agreement with Nernst's law.—*Translated and abstracted from the Zeitschrift für Elektrochemie (Breslau), May 21.*

Electromagnetic Apparatus for Speed Variation.

A neat arrangement for securing speed variation of automobiles is here described by M. F. Drouin. This is known as the Germain system, and the equipment consists of a small gasoline engine, a dynamo and a motor. The engine drives directly the field of the generator. The armature of this generator is carried on a shaft which also carries the armature of the motor and a beveled gear which drives the axle of the vehicle. The generator and motor are both series machines, and are connected in series. For regulation, a resistance is connected in shunt with the motor field. The speed is varied by varying the amount of this resistance in circuit, and thereby varying the strength of the motor field. This, of course, varies the counter electromotive force developed in the motor armature, and thereby the speed of the latter. Since the motor and generator armatures are connected together mechanically and electrically, both must revolve at the same speed. When the carriage is standing still the circuit is open. To start the carriage, the circuit is closed, and the entire regulating resistance is placed in parallel with the motor field. The strong field thus produced causes the shaft to revolve at a low speed, and since the field of the dynamo is revolving at a constant speed, the slip of the dynamo armature relative to its field is large, and therefore a heavy current and strong turning effort are developed in both machines. As the resistance is cut out, the motor field decreases in strength, and the speed of the shaft increases until, on the last notch, the motor field is short-circuited, and this machine is therefore inoperative, the dynamo acting merely as an electric clutch. With this arrangement the direction of rotation of the shaft can not be reversed, so that two beveled gears are provided on the driven axle to allow for running in either direction. The motor, however, can be used as an electric brake.—*Translated and abstracted from the Revue Pratique d'Electricite (Paris), May 20.*

Symmetry of Telephone Lines.

This article discusses the theory of the transmission of telephone currents, showing that these follow the laws of simple alternating currents. Then the question of induction is considered, and it is shown that by proper arrangement of lines, the induced currents in the line may be made to balance each other. Experiments were made on a line about fifty kilometres long, one side of the circuit being single-conductor, and the other made up of two or more conductors. By a proper arrangement of the latter, a neighboring telegraph circuit had no effect upon a telephone line. In one experiment the outgoing line was formed of a single wire, and the return line of two parallel wires placed symmetrically with respect to the telegraph line, but not connected together, one of these wires running from each end of the circuit. This line was in no way affected by currents in the telegraph circuit, but formed a satisfactory telephone circuit. The author then calls attention to the importance of the careful arrangement of telephone lines with respect to their electrical circuits, and says that if as much care were expended in this direction as is taken to ensure good insulation, much improvement would result.—*Translated and abstracted from l'Electricien (Paris), May 23.*

The Hydroelectric Station of Cenischia, Italy.

This article by Signor Enrico Bignami, describes the development of the water power of the Cenischia River. This creek rises on the slope of a chain of the Alps, extending from the Bard Glacier to the Lamet Glacier, from a high plateau in which lies Lake Cenisio. The altitude is 6,250 feet above the sea. The outlet of the lake is the Cenischia stream, of variable volume, the minimum flow of which is estimated at about 800 litres per second. This stream in its course receives the output of two small lakes, and after flowing some distance turns sharply to the east and plunges to the bottom of the valley, having a fall of nearly 900 metres in a course of about five kilometres. There are two plans for developing this power. One contemplates breaking the fall into two parts, and constructing two stations. The other, or later one, proposes to utilize the entire fall at one station. Work is now going on in erecting and equipping a power station at the bottom of the fall, but the penstock at present extends only a little more than half way up, the water being carried to that point in a covered canal, which lowers the water in a series of steps. Head works are being constructed to regulate the flow of the lake, raising it from the minimum of 800 litres to an average of 1,000 litres per second. The station contains now three groups of turbo-alternators, each of 1,600 horse-power, the turbines operating with an effective head of 436 metres, and requiring 360 litres per second. Water is delivered to the turbines through a horizontal cast-steel pipe extending inside the wheel, where it is bifurcated, and terminates in two distributors with nozzles of variable section, suggesting in their construction the slide valve of the steam engine. The alternators are 1,400-kilowatt, 3,000-volt, twelve-pole machines, with a frequency of fifty periods per second. Step-up transformers raise the pressure to 30,000 volts. The lines are carried on steel poles by means of triple-petticoat insulators. By an ingenious arrangement of the switchboard wiring, current in all three phases of the line is measured by means of two series transformers. The transmission line will run from the station at Novalesa to Turin, sixty-one kilometres.—*Abstracted from the Engineering Magazine (New York), June.*

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

ASSOCIATES ELECTED AT DIRECTORS' MEETING, NEW YORK, TUESDAY, MAY 19, 1903.

Harry Clinton Abell, Montgomery, Ala.
William Philip Abendroth, New York city.
Alexander Henry Ackerman, Brooklyn, N. Y.
Lucius Buckley Andrus, Columbus, Ohio.
William G. Angus, Hamilton, Ontario.
Milan V. Ayres, South Framingham, Mass.
Ralph Emerson Barker, Lynn, Mass.
W. H. Beattys, Jr., Western Springs, Ill.
Charles Hampton Bedell, Swarthmore, Pa.
Max A. Berg, Chicago, Ill.
Carl Athearn Bessey, Schenectady, N. Y.
Edwin Tyler Blake, Mount Bullion, Cal.
Charles Ayres Bray, Schenectady, N. Y.
Graham Bright, Pittsburg, Pa.
Dickson Queen Brown, New York city.
Sydney William Brown, New York city.
Waldo Calvin Bryant, Bridgeport, Ct.
William Gibson Burns, New York city.
Isaac Nelson Butterworth, Davenport, Iowa.
Frederick John Chisholm, Pittsburg, Pa.
Charles William Clack, London, England.
Clarence Doane Clark, Sacramento, Cal.
Henry P. Clausen, Chicago, Ill.
Safford Kinhead Colby, Flushing, L. I.
William Rawson Collier, Atlanta, Ga.
C. A. Cornwall, Ashcroft, B. C., Canada.
Robert Dahlander, Stockholm, Sweden.
John Clarence Davidson, Prince's Bay, N. Y.
Ward Decker, Oswego, N. Y.
Walter S. Dix, Brooklyn, N. Y.
Will Montague Dixon, St. Louis, Mo.
Keith Donaldson, New York city.
Charles James Dougherty, Germantown, Pa.
Herbert William Dow, Ames, Iowa.
Edgar Selah Downs, Pittsburg, Pa.
John F. Dusman, York, Pa.
Frank Hall Eastman, Falls Church, Va.
Johannes S. Edstrom, Westeras, Sweden.
Thomas Elliott, Connellsville, Pa.
Frank Joseph Engelhorn, Boise City, Ida.
Henry Wallace Fellows, Lewistown, Mont.
Clarence Feldman, Darmstadt, Germany.
William Loveday Fergus, Chicago, Ill.
William T. Fernandez, New York city.
Sebastian Z. de Ferranti, London, England.
Allan Bertram Field, Schenectady, N. Y.
William A. Fox, Chicago, Ill.
Howard Ludloy Gilbert, Wilkinsburg, Pa.
Frank Gill, Beckenham, Kent, England.
John Girdlestone Glassco, Montreal, Quebec.
George Byron Gordon, New York city.
Ernest T. Goslin, Glasgow, Scotland.
Louis Henry Haight, Amityville, L. I.
Frederick James Hall, Yonkers, N. Y.
Philip Hamlin, Denver, Col.
Samuel Clark Harris, New York city.
Gilbert Alexander Harvey, Buffalo, N. Y.
George Myron Haskell, New Haven, Ct.
George A. Hoadley, Swarthmore, Pa.
Alexander D. Hoeftmann, Worcester, Mass.
Joseph Hollos, Budapest, Austria, Hungary.
Ole C. Hovland, Chicago, Ill.
John Means Humiston, Berwyn, Ill.
Charles Smith Jameson, Swampscott, Mass.
Walter G. Jayne, Columbus, Ohio.
Frank K. Jewson, London, N. England.
Lynn S. Kedney, Jalapa, V. C., Mexico.
Fred Orrin Kinnecom, Providence, R. I.
George Laurence Knight, Camden, N. J.
Seymour Knight, Upper Troy, N. Y.
Benjamin Garver Lamme, Pittsburg, Pa.
Arthur Hamilton Lawton, Glens Falls, N. Y.
Francis N. Lawton, Hackensack, N. J.
A. H. Lidderdale, Hertfordshire, England.
Gustav Lindman, Stockholm, Sweden.
Bradford Homer Locke, Denver, Col.
Harold Lomas, Denver, Col.
Walter L. Macfarlane, Westmount, Quebec.
John P. Madsen, Adelaide, South Australia.
Charles T. Malcolmson, St. Louis, Mo.
William Lowry Mann, Ithaca, N. Y.
William McClelland, Manchester, England.
Walter Ehmsen McCoy, New York city.
M. C. McKay, Vancouver, British Columbia.
W. McLellan, Newcastle-on-Tyne, England.
Carl Leo Mees, Terre Haute, Ind.
Charles Robert Meston, St. Louis, Mo.
Perry F. Miller, Chicago, Ill.
George Halstein Morris, West Lafayette, Ind.
Charles Tyler Mosman, Schenectady, N. Y.
Paul Alphonse Mossay, Rugby, England.
Charles William Naylor, Chicago, Ill.
Harry William Olmsted, Hackensack, N. J.
Captain C. F. Parker, Willets Point, N. Y.
Karl Almon Pauly, Schenectady, N. Y.
Henry Mark Pease, London, England.
George Albert Pierce, Jr., Philadelphia, Pa.
James A. Pietsch, San Juan, Porto Rico.
Charles Richardson Pratt, Montclair, N. J.
Frederick George Proutt, Memphis, Tenn.
Henry Linton Reber, St. Louis, Mo.
Ernest A. Regestein, South Bethlehem, Pa.
William I. Reich, Wilkinsburg, Pa.
Frederick Reichenbach, Washington, D. C.
Clarence Erle Reid, Lafayette, Ind.
Edward L. Reynolds, Philadelphia, Pa.
Martin G. Ribon, Mexico City, Mexico.
Antoine Rush Rivet, St. Louis, Mo.
J. J. R. C. Rogers, Sydney, New South Wales.
Walter A. Royse, Indianapolis, Ind.
Louis Milton Schmidt, Lynn, Mass.
Albert Vincent Schroeder, Springfield, Ill.
Schwennicke, Solingen, Germany.
Edward H. Scofield, Minneapolis, Minn.
Joseph B. Seaman, Philadelphia, Pa.
Walter Allan Seymour, New York city.
Frederick Bassett Sharpe, Liberty, N. Y.
Irvin Howard Sherwood, Cleveland, Ohio.
Earl D. Silver, West Lafayette, Ind.
William A. Smethhurst, Washington, D. C.
Harry G. Spain, Georgetown, British Guiana.
Frank Benjamin Spencer, Chicago, Ill.
Thomas Spencer, Philadelphia, Pa.
Louis Bevier Spinney, Ames, Iowa.
J. Herbert Steele, Cincinnati, Ohio.
Claire P. St. John, Brooklyn, N. Y.
Frederick G. Sykes, Schenectady, N. Y.
Charles Frederick Tischner, Brooklyn, N. Y.
Albert Lincoln Tucker, Evanston, Ill.
Manly Curry Turpin, Schenectady, N. Y.
George Laurie Walker, Pittsburg, Pa.
John Abbet Walls, Montreal, Quebec.
James Walsh, Lynn, Mass.
Kenneth Watson, Schenectady, N. Y.
Arthur Edwin Wells, New York city.
Eddy Russell Whitney, Swampscott, Mass.
Frederic Shelton Wilhoit, Milwaukee, Wis.
Walter Edwin Winship, New York city.
Henry Wilmot Woodward, Cleveland, Ohio.
John H. Woolliscroft, Chester, England.

TRANSFERRED FROM ASSOCIATE TO FULL MEMBERSHIP.

Merle J. Wightman, New York city.
Charles O. Poole, Denver, Col.
Herbert T. Hartman, Philadelphia, Pa.
Raymond S. Kelsch, Montreal, Quebec.

The Commencement Exercises at Worcester Polytechnic Institute.

The commencement exercises at Worcester Polytechnic Institute, Worcester, Mass., were held last week. On Tuesday the annual commencement lecture was delivered before the Washburn Engineering Society by Professor Harold B. Smith, the subject being "The Relation of the Electrical Engineer to Modern Social and Industrial Progress." The commencement address was delivered by Mr. O. H. Tittmann, superintendent of the United States Coast Geodetic Survey, upon "The Work of the United States Coast Geodetic Survey." This was followed by the annual alumni dinner, and the buildings were thrown open for the inspection of visitors.

BOOK REVIEWS.

"Small Electric Motors." F. E. Powell. London. Dawbarn & Ward, Limited. Paper. 75 pages. 5 by 7¼ inches. Numerous diagrams. Supplied by the ELECTRICAL REVIEW at 25 cents.

The author of this little book has aimed to give very young readers and students an idea of how to produce a really practical motor. While it has been necessary to condense the matter into the smallest space, the endeavor has been made to omit nothing of vital importance. Of course it can not be seriously expected that the amateur will proceed very far in his knowledge of machine construction by instruction of this kind, but he no doubt will be stimulated to a more extended endeavor.

"India-Rubber and Gutta-Percha." Translated from the French of T. Seeligmann, G. Lamy Torrilhon and H. Falconnet. John Geddes McIntosh. New York. D. Van Nostrand Company. Cloth. 402 pages. 6½ by 9½ inches. Supplied by the ELECTRICAL REVIEW at $7.50.

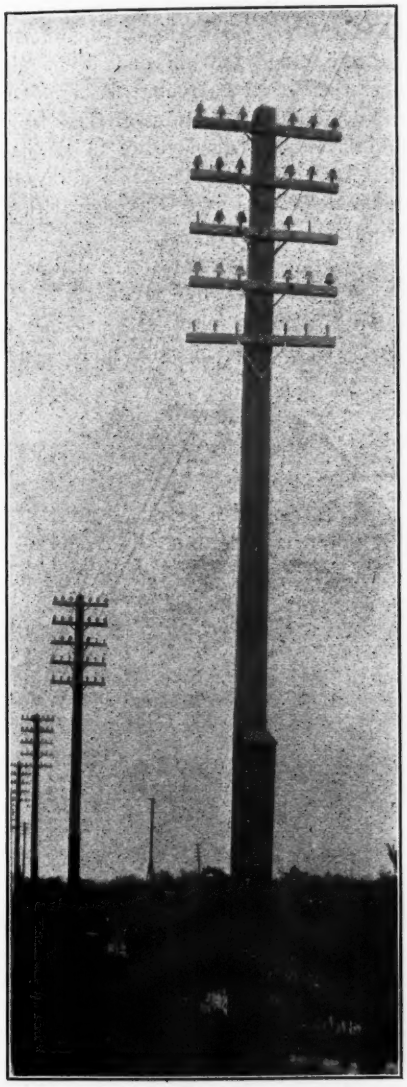
This book has been prepared by the collaboration of a well-known technical chemist, an equally well-known india-rubber manufacturer, and an expert mechanical engineer with special experience in connection with india-rubber and gutta-percha plants and machinery, with the object of supplying a treatise which would cover the subject completely. Many of the text-books heretofore published, while having much merit, dealt with the subject from a special point of view, and there is none which attempted to bring together all the important facts and to describe the many successful methods of converting the raw gum into useful articles.

The first part of the book deals with india-rubber, and the second with gutta-percha. Each section has an historical introduction, giving a chemical description of the various species of plants, and describing the rational methods of culture and processes of harvesting and preparing the different products, designating the good and bad points of the several methods. The physical and chemical properties of india-rubber are considered and methods of technical testing and synthesis of rubber are given. The mechanical transformation of the natural gums into materials suitable for the various purposes to which they are applied and the machinery used in these processes are described in detail. Methods of mixing the gum with other material and substitutes for the gum are given. Statistical tables show the production of rubber and gutta-percha for the past twenty years, and their use. The book is completed by an excellent bibliography of articles relating to rubber and gutta-percha.

SETTING OF THE POLES FOR THE POWER TRANSMISSION LINES OF THE NEW ORLEANS DRAINAGE SYSTEM.

BY WILLIAM MAYO VENABLE.

In 1898 there was erected in New Orleans a line of poles carrying transmission lines for the power used at the various electrically driven pumps of the drainage system. The line construction was of the ordinary kind, for three-phase



POLE LINE OF THE POWER TRANSMISSION SYSTEM OF THE NEW ORLEANS DRAINAGE SYSTEM.

circuits of 3,150 volts. The pole line runs part of the way in a swamp, and on that part of the line the poles were originally fastened to piles driven into the swamp by a pile driver. The pile driver was carried on a railway car, on a track which ran parallel to the pole line. The pile driver was built especially for this purpose. This driver was taken apart after the line was built. It could be used only between trains, and a special locomotive was required to move it along the line, making the work quite expensive.

After four years many of the piles were so badly rotted at the surface of the ground that it was found advisable to replace them; and in order to avoid a recurrence of the same trouble the construction was changed. Instead of piles, concrete receptacles were built in the ground, into which sound timber was inserted, to which the poles were bolted. The timber which fits into the concrete is renewable at will, at comparatively small expense. It is thought by this means to greatly reduce the cost of maintenance of the line, due to the rapid decay of timber exposed to the action of the soil and atmosphere in this climate. Over a hundred poles were supported in this manner, and the rotted piles cut away. The method could probably be used to advantage elsewhere. The form of construction is shown in the accompanying sketch.

This photograph shows the pole line running in the swamp before the method of supporting the poles was changed. The appearance after the change was altered only by the support being placed on the other side of the pole and the pile which shows in the photograph being cut off.

The Convention of the Canadian Electrical Association.

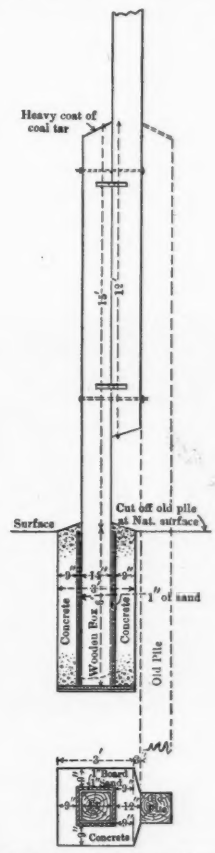
The following programme was announced for the thirteenth annual convention of the Canadian Electrical Association, June 10, 11 and 12. The headquarters of the association was the King Edward Hotel, Toronto.

Wednesday, June 10—10 A. M., meeting of the executive committee; 11 A. M., opening of convention in Assembly Hall, King Edward Hotel, address of welcome by the Mayor of Toronto, president's address, reading of minutes, reports of secretary-treasurer and committees, general business, paper on "Long-Distance Transmission," by Mr. Paul M. Lincoln, of Pittsburg, Pa., question box.

Thursday, June 11—10 A. M., reading of the following papers: "Individual Electric Drive and Its Relation to the New Shop Methods," by Mr. R. T. Lozier, Cincinnati, Ohio; "Some Points Relating to Submarine Power Cables," by Mr. G. H. U. Holman, Quebec. At 2 P. M. the following papers were to be read: "Single-Phase Alternating Motors as a Means of Increasing Station Earnings," by Mr. W. A. Layman, St. Louis, Mo.; "Transformers for High-Voltage Transmission Lines," by Mr. J. W. Farley; the remainder of the session to be devoted to general business and the question box.

Friday, June 12—Selection of place of next meeting, election of officers, unfinished business.

The following social features had been arranged: On Wednesday, June 10, at 4 P. M., a tally-ho drive to points of interest in the city, by courtesy of the Canadian General Electric Company; at 8 P. M. of same day, an excursion by special steamer and band concert at Toronto Island. On Thursday, June 11, at 4



THE POLE SETTING FOR THE POWER PINS OF THE NEW ORLEANS DRAINAGE SYSTEM.

P. M., visit by special cars to the works of the Canada Foundry Company, by courtesy of the company, and at 9 P. M., annual association dinner, King Edward Hotel.

A Precaution in the Use of Connectors.

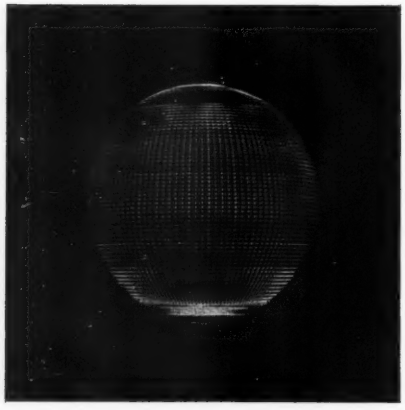
When concentric connectors are used they must be constructed so that they can not be readily short circuited by a piece of metal, such as a pin or a metal pencil case. Clearance should be such that an arc can not be started if the connector is pulled out at the time that the current is flowing. The insulation used between opposite poles should be such that it will not readily break or chip.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Exhibit of the Holophane Glass Company.

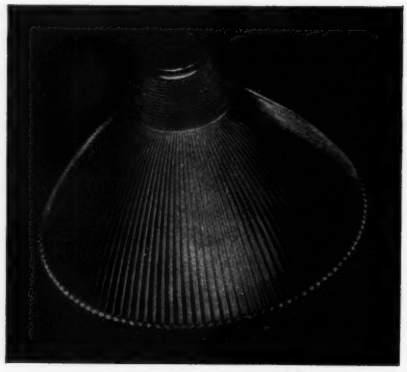
The Holophane Glass Company, 15 East Thirty-second street, New York city, had an attractive exhibit at the Auditorium Hotel, Chicago, during the convention of the National Electric Light Association. A large number of attendants at the convention visited this exhibit, many of them several times. The company had a room fitted with samples of all its Holophane globes and "Pagoda" prismatic reflectors, amounting to something over 200 different sizes and shapes for all sorts of artificial lights. A temporary popular photometer was erected at one end of the dark room, where the efficiency of Holophane glass globes was demonstrated, comparison being made



HOLOPHANE GLASS SPHERE.

with both ordinary glass and bare lights. The photometer was stationed at one end of the room, divided by a partition, lights being on each side, so that the actual lighting result of a Holophane globe, as against a number of other lights, could be judged by the eye, without the necessity of any scientific measuring instruments.

The company distributed a souvenir in the shape of neat cardboard boxes containing three samples of its best-selling upright and pendent Holophane scientific glass globes and "Pagoda" prismatic reflectors. These were given away to every representative of an electric manufacturing company or electric light plant. The "Pagoda" prismatic reflectors attracted a great deal of attention, owing to the fact that they are of newer design, and possess a very high concentrating power of light. The "Pagoda" reflectors come in sizes from five inches in diameter to eighteen inches in diameter, fitting all size holders from one and one-half inches to six and



PRISMATIC REFLECTOR.

one-eighth inches. They are made in all shapes, and will be placed on the market during the coming season. There is absolutely no silver, paint or amalgam used on these reflectors, and the original efficiency is permanent throughout the life of the material.

The company was represented by V. R. Lansingh, H. M. Lauritzen, E. H. Lourey, H. D. Howe and R. J. Holden, and the encouraging and flattering comments made by those who visited the display, assured the company of the increasing popularity of its material.

Self-Flashing Sign Lamps.

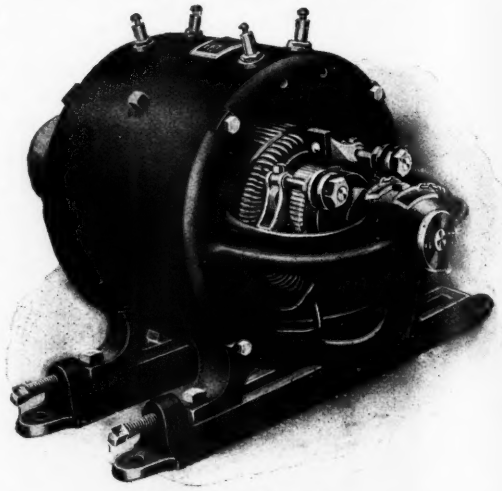
The Phelps Company, of Detroit, Mich., has developed a new sign lamp which is

PRISMATIC REFLECTOR.

possessed of considerable novelty. The filaments are of the well-known "Hylo" type which this company manufactures, arranged to give one and sixteen, one and eight, or eight and sixteen candle-power. The mechanism for operating the flasher is concealed inside an ordinary Edison base. This mechanism turns the light up and down from the big to the baby filament at irregular intervals. Each lamp is an independent unit, and runs on its own time card making a kaleidoscopic effect. With these lamps an endless variety of movements may be secured, differing entirely from the rotation or regular operation of the circular flasher. One of the important features of these lamps for advertising display lies in the fact that one of the filaments is always illuminated, not leaving the sign dark at any time.

Two-Kilowatt Dynamo.

A great many electrical machines of moderate size are installed under condi-



TWO-KILOWATT DYNAMO.

tions where they receive very little skilled attention. Inexpert persons have the handling of apparatus of this size to a greater degree than with machines of larger capacities. It is necessary, therefore, with machines of small size that the parts be assembled with great simplicity, and with the minimum of necessary adjustment. At the same time, the conditions require that the machines should be thoroughly well built, both mechanically and electrically, in order that they may stand injury, to say nothing of accidental abuse.

The accompanying illustration shows a two-kilowatt dynamo which is one of a line of machines ranging from one-half kilowatt to twenty kilowatts which is being made by the Hobart Electric Manufacturing Company, of Troy, Ohio. The

company states that these machines have been made as strong and simple as is consistent with good engineering practice. In order to avoid trouble under continuous heavy service or adverse conditions, the line has been rated very conservatively, and is, therefore, not only capable of giving the rated output continuously without distress, but the machines will also stand severe temporary overloads.

The construction is of the conventional multipolar type, with radial pole-pieces mounted in a circular frame, both frame and pole-pieces being of Tropenas steel. This particular steel has been selected because of a series of exhaustive tests which has shown it to be well fitted for this service, and because of a peculiar process ensuring uniform quality of metal of high permeability.

In most of these machines the pole-pieces are cast separately from the frame and bolted to the same. The seats for the pole-pieces are turned concentrically with the shaft, and give a joint of low magnetic resistance.

The field coils are layer-wound, and are of circular cross-section. Before being placed on the pole-pieces they are carefully insulated, and are so strengthened as to resist severe strains due to the sudden breaking of the field circuit or to any outside impressed force.

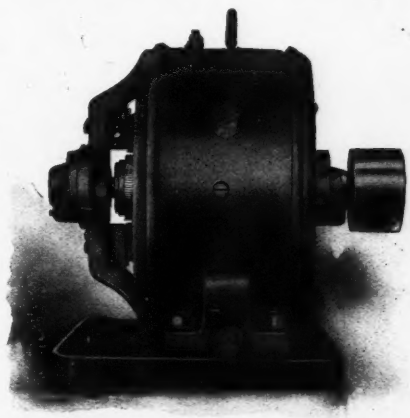
The armature has been the subject of great care, both in design and construction. These armatures are of the ironclad type. The coils are form-wound, and thoroughly insulated before being placed in the slots. These slots are previously additionally insulated to receive the coils. The commutator is of liberal construction, and so designed as to reduce heating of this part of the machine and presenting a large surface for wearing strain.

In the construction of these machines a novel feature is introduced in the design of the bearings. These are large, self-aligning, and, in addition, have a special adjustment for centering the armature with the magnetic centre of the frame. The parts are all made to jigs and templets, the turning is done true to gauge, and the building ensures correct fitting of all the parts.

Direct-Current Motors.

The accompanying illustrations show two views of the type "B" direct-current motor made by the Bullock Electric Manufacturing Company, Cincinnati, Ohio. This line of motors has been built with the idea of supplying a strictly first-class and up-to-date, though moderately priced, motor. The line is built in sizes ranging from one horse-power to ten horse-power in slow speeds, and from two horse-power to fifteen horse-power in moderate speeds. The machines are made with either open or enclosed ends, as desired. The enclosed motor is dust and moisture-proof, and is adapted for service in places where the use of an open motor would be prohibited. The machines are designed to be installed either upon the floor, ceiling or side wall.

The motor frame is of cast steel, cylindrical in form, and of comparatively large diameter, providing ample room for field



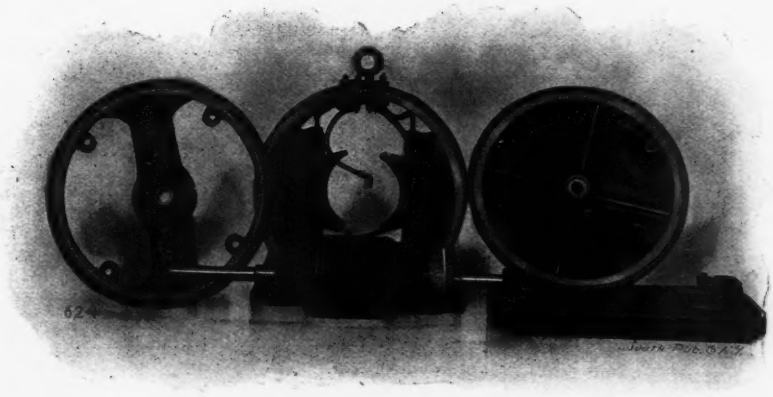
2½-Horse-Power Motor.

coils and accessories, as well as good ventilation and large radiating surface. Laminated poles, bolted through the yoke, are used, and, in erecting, great care is used to have these accurately spaced. Extended tips on the pole-pieces are utilized to hold the field coils in place, and assist in the distribution of the magnetic flux in the air-gap. The end housings on the open motors are made as open as possible, and consistent with firmness and strength. All commutator end housings are provided with seats which are machine finished to receive the sheet-iron covers used on the enclosed motors. All leads are brought out through a porcelain bushing extending from the top or side of the frame, and babbitted into it. This porcelain also serves as a connecting board.

The armature core is laminated and is built up from thin sheet steel. The discs, after being annealed, are japanned, and assembled directly on the shaft. They are held firmly together between two malleable iron end-pieces which act as supports for the armature coils. Air ducts for ventilating the core and windings are provided by inserting ventilating plates at regular intervals. The armature coils are made of copper wire, machine formed, and are insulated with a double wrapping of oiled muslin and taped throughout with one-half lap linen tape. The coils are tested during the process of winding, so as to detect any possibility of a short-circuit in the coils of the completed armature. The manufacturer states that this insulation will stand a puncture test of from 3,000 to 4,000 volts alternating. The windings are led into the slots of the armature core, and are held firmly in place by band wires on the smaller sizes; and on the six horse-power and larger sizes, these windings are bound in place by seasoned hard-wood wedges.

The commutator bars or segments are made from pure hard-drawn copper, of ample length and wearing depth. The mica insulation used between the segments is from selected stock of uniform hardness, and wears evenly with the copper segments. The armature conductors are soldered directly in the slots of the segments.

The brush-holder mechanism is simple in construction. It is arranged for carbon brushes of the reaction type, and is attached to wooden blocks which are fastened to babbitted seats on the end housings.



7½-Horse-Power Motor Disassembled.

The brush, itself, is provided with an attachment which prevents it from dropping out of the holder when released from the pressure of the brush-holder arm.

The bearings are a part of the cast-iron end shields which are bolted to the frame. By turning these end shields around, the motor can be arranged to operate on the side wall or ceiling. Oil wells and revolving rings provide automatic lubrication, and cool running is ensured by liberal bearing surfaces.

Alcohol as Fuel for Internal Combustion Engines.

Tests made by C. W. Weiss, at the Mietz & Weiss Engine Works, 128 to 138 Mott street, New York city, with Cuban and Brazilian cheap alcohol as fuel in the standard kerosene engine made at this works, are reported by the company to be entirely satisfactory. The object was to substitute alcohol for kerosene, the former being cheaper and more readily obtained in Cuba and South America, where many of these machines are being exported. It is stated that a mixture of four pints of alcohol and two pints of water develops four horse-power for one hour. The mixture of alcohol varies, however, with the quality of the former, being limited by the practical degree of compression prior to combustion. The specific gravity of the mixture is 0.9. That of the pure alcohol was 0.794.

The Exhibit of G. M. Gest.

Mr. G. M. Gest, conduit contractor, New York and Cincinnati, during the convention of the National Electric Light Association, at Chicago, exhibited at the Auditorium Hotel a number of specialties in the way of cable racks, conduit terminals and other devices for improving and perfecting cable construction in the manholes of an underground system.

The cable rack, which is built on entirely new lines, is capable of supporting any number and size of cable, being made in three standard sizes, from one to five feet long, as the construction may require. The brackets for this rack are adjustable to any angle, and this is an important feature in placing the cables in difficult positions in the manholes. Both the rack and the holders are made of especially heavy galvanized iron, and there is little chance of corrosion or deterioration. An important feature of these racks is that they are set flush with the brickwork, being built in such a manner that they occupy practically no additional space in the manhole.

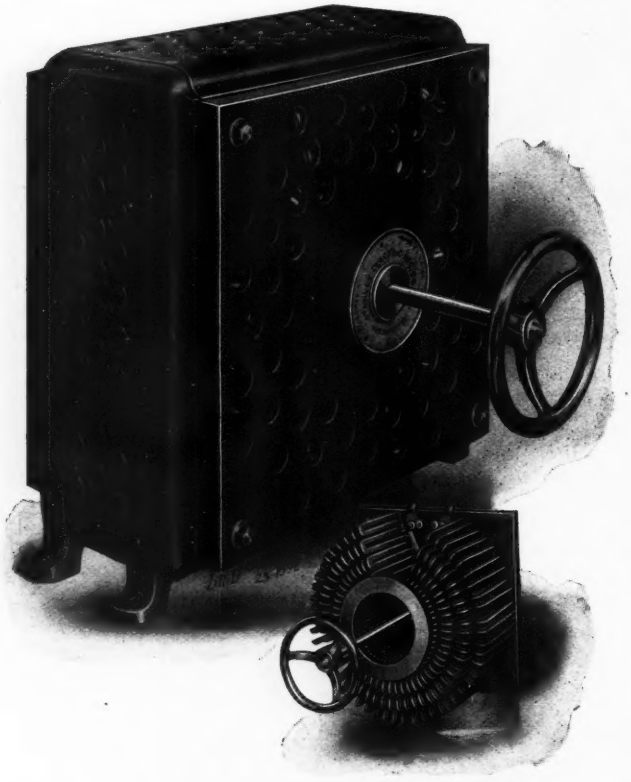


FIG. 1.—CAST GRID RHEOSTAT, COMPLETE AND WITH COVER REMOVED, SHOWING RADIAL ARRANGEMENT OF UNITS.

There were also on exhibition several of the new enameled terminal brick, the patents for which have just been allowed. These are claimed to be an improvement over the terminal device recently placed on the market. The advantage of this particular type of terminal is said to be its capability of rigid adjustment to either a small or large conduit run, provision being made for necessary corner pieces, to meet any possible combination or arrangement of ducts. These terminals are being used extensively on several large installations, especially at Louisville, Ky.; Cincinnati, Ohio, and Boston, Mass., and the demand for them is rapidly growing.

A new mandrel for cleaning and rodding ducts was shown which possesses many features of merit.

A new type of automatic self-cleaning trap for sewer connection with a novel back-water valve, was exhibited. This is made in all sizes, and is already on the market.

Mr. Gest was represented at the convention by Mr. W. T. Jackson, of Cincinnati, and Mr. F. C. Mott, of New York.

Cast Grid Rheostats.

The Stanley Electric Manufacturing Company, of Pittsfield, Mass., is placing on the market a rheostat, the features of which are readily shown in the accompanying illustrations. In this rheostat resistance units are directly connected to the contact studs. This obviates the use of soldered contacts, set screws, or any such combination, and also entirely obviates the use of connecting wires.

This rheostat consists of fifty to sixty iron grids, radially arranged, as shown in the lower part of Fig. 1. This arrangement results in an exceedingly simple and compact mechanical construction. Each unit, as shown in Fig. 2, is formed with a projection extending at such an angle from the plane of the unit proper as to permit direct-connection with the next unit.

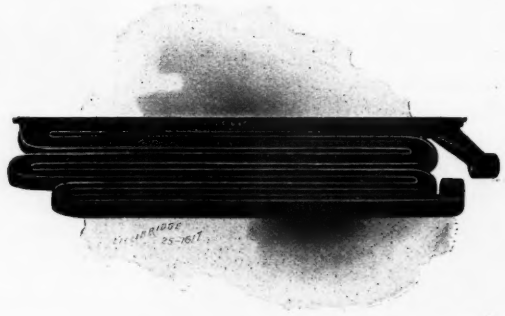


FIG. 2.—RESISTANCE UNIT.

A contact stud passes through two adjoining units, furnishing electrical connection between them and supporting them in place, at the same time supplying a contact surface for the contact arm. Each unit is thus firmly fastened by two studs or bolts to the substantial slate slab through which the studs pass. A corresponding slate slab on the other side provides additional support to the units, resulting in a rigid outfit. The whole apparatus is mounted in a substantial and well ventilated iron case.

The resistance units are cast of such shape as to furnish the best possible radiating and convective surface. The contact arm is very broad, giving a good contact surface and permitting a ready dissipation of heat. The chief merit of the apparatus is claimed to be its absolute freedom from weak points and the practically indestructible nature of its elements.

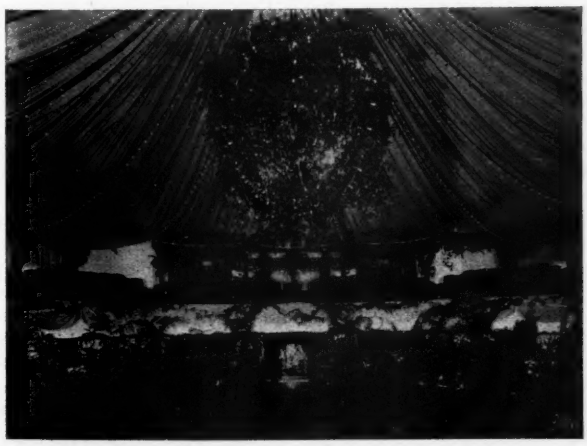
Decorative and Sign Lighting.

Within very recent times, the use of incandescent lamps for decorative and sign lighting has grown to proportions which can hardly be imagined. Not only does this apply to advertising effects, but the ingenuity or artistic ability of the engineer is taxed to its limit to provide proper installations for church, theatrical and private illumination. Mr. Arthur Williams, of the New York Edison Company, presented, in an able report made to the twenty-sixth annual convention of the National Electric Light Association, a concrete idea of the wonderful effectiveness of the incandescent lamp in producing illuminating effects, the report being supplemented by a collection of beautiful pictures portraying this accurately and comprehensively.

Building, New York City, Decorated with Electric Lights.

The accompanying illustrations have been selected from among the engravings which supplemented Mr. Williams's report as typical of what may be accomplished with the use of the "Elblight" system which is installed by the Elblight Company of America. The Elblight system consists of twin conductors and electric lighting boards. The conductors are so arranged that they may be draped or intertwined in any fashion, the lamp unit being furnished with two sharp copper terminals, which, upon being stuck into the twin conductors, completes a lamp circuit. Small incandescent lamps with frosted bulbs of various colors are used, and the flexibility of this system renders it applicable to any position.

With the lighting boards, the lamps are stuck into an insulating cover, underneath which is a series of conductors so arranged that no matter where the lamp terminals are inserted a circuit is closed. This renders the tracing of any letter or of any design very easy, and, with the flexibility of the twin conductor system, allows of a very extensive use for all forms of display.

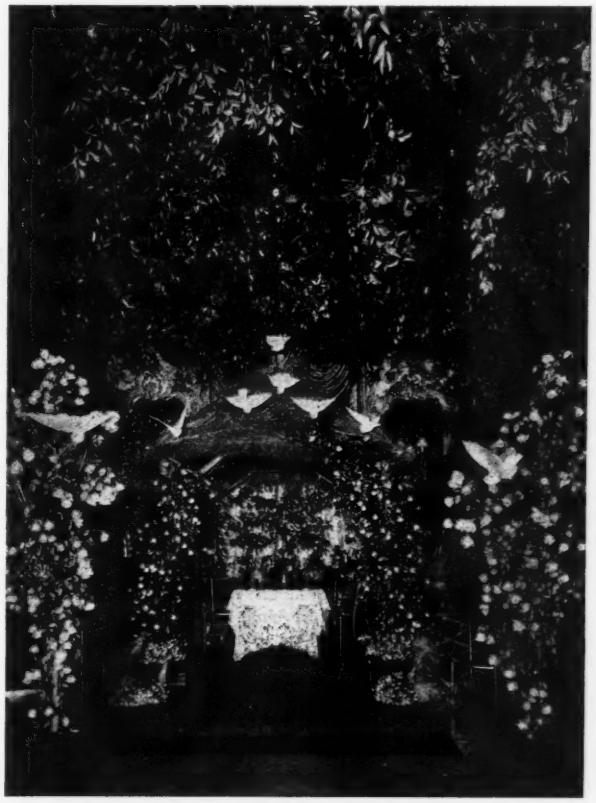


Ceiling and Wall Decorations, Consisting of Smilax, Ferns and Electric Lights.

The headquarters of the Elblight Company of America are at 114 West Thirty-second street, New York city.

At the recent convention of the National Electric Light Association, in Chicago, the Elblight Company was represented by Mr. Russell Spaulding, president; Mr. E. H. Abadie, general manager, and Mr. J. Allen Haines, western manager. The company had its exhibit in the parlors of the Auditorium Hotel.

The South Parlor was handsomely decorated with "Elblight" cable and "Elblight" miniature lamps of many colors, festooned and all covered with a profusion of greens. Portières of "Elblight" cable and lamps covered with greens were in the doorways and lent to the reception to the delegates, ladies and members, a festive appearance. There were also exhibited some decorations, consisting of portières and flags, together with a large collection of photographs showing the many important and artistic decorations made throughout the country with the "Elblight" system, and an aquarium with "Elblight" cable and a lamp burning under water. The lamp shown had previously been burning continuously under water for over three months without deterioration.



A Home Altar for Wedding Ceremony.

The Kellogg Switchboard and Supply Company.

The Kellogg Switchboard and Supply Company announces that suit was begun last Friday by the minority stockholders which will be contested. The president of the company, Mr. W. L. De Wolf, is authority for the statement that the business of the company will be continued, all contracts will be fulfilled and additional apparatus furnished as required; that bonds will be furnished to its customers for the fulfilment of its contracts and furnishing additions the same as heretofore.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

EXTENSIVE IMPROVEMENTS FOR PACIFIC TELEPHONE SYSTEM—It is announced that the Pacific States Telephone and Telegraph Company is preparing to expend $1,500,000 during the next twelve months in rebuilding its plant, and it is proposed to put the local establishment on a basis to accommodate 100,000 subscribers. It is stated that President John I. Sabin, who recently returned from Chicago, has determined upon these improvements, which will include new buildings or large additions to all the exchanges, new and improved switchboards and exchange connections, and new telephones of the most modern type.

NEW POWER AND WATER COMPANY—A new company, to be known as the Glenville Power and Water Company, has been organized in Greenwich, Ct., with a capital of $10,000,000. It is expected that the legislature will pass a resolution, now pending, incorporating it. The company seeks a franchise to supply water to Greenwich, Ct., Rye, Harrison and Mamaroneck, N. Y., as well as to generate and distribute electricity throughout these and other sections for public and private use. The charter confers large powers of eminent domain in securing land for water-shed and reservoir purposes. William J. Tingue, Nathaniel Wetherell and Henry H. Adams are the incorporators.

A MORTGAGE FOR $20,200,000—A chattel mortgage for $20,200,000, given by the Public Service Corporation to the Fidelity Trust Company, has been filed in the county register's office in Newark, N. J., covering all stock of the United Electric Company and the trolley companies turned over to the new corporation recently in accordance with the merger proposition. The number of shares of stock is enumerated as follows: North Jersey Street Railway Company, 138,069; Jersey City, Hoboken & Paterson Street Railway Company, 200,000; Elizabeth, Plainfield & Central Railway Company, 89,019; United Electric Company, 181,469. The mortgage was executed on June 1, and was given to guarantee the payment of the interest-bearing securities awarded to holders of stock who surrendered their shares to the new corporation.

INTERSTATE TRACTION MERGER—The Indianapolis Northern and the Union Traction Company have effected a consolidation involving a capital of $8,500,000 and nearly 300 miles of electric interurban lines. Of the capital stock $5,000,000 represents that of the Union Traction Company, and $3,500,000 that of the Indianapolis Northern. The headquarters of the new company will be at Anderson, Ind., and the present directors of the Union Traction Company will continue in authority until new directors are elected at the stockholders' meeting. It is said that the merger of the Indianapolis Northern and the Union Traction Company is the first step in the general consolidation of all the Indiana traction lines. The lines from Marion to Fort Wayne, from Logansport to Chicago, and from Anderson to Newcastle, all of which will be completed during the year, will later be included in this syndicate. A line from Logansport through Kokomo and Marion will also be built in the near future.

PENSION FOR OLD EMPLOYES—Announcement has been made of the intention of the Postal Telegraph-Cable Company to institute at an early date a pension system for the benefit of old employés needing aid. The provisions of the plan are set forth in the circular which has been issued by the management of the company to the employés. It was the earnest desire of the late President John W. Mackay that some provisions should be made by the company for the benefit of faithful employés who had grown old in the service, and whose usefulness had been impaired by age or misfortune. After long and careful consideration, the management, while it has not been able to formulate a systematic plan of pensions, has authorized the following announcement: "Any employé of the Postal Telegraph-Cable Company who has been continuously in its service for a period of fifteen years, and who, through no indiscretion of his own, has become incapacitated for work, may apply for relief to the person under whose immediate direction he is employed. Upon the recommendation of such person and of the superintendent of the district in which the employé is located, and with the approval of the general superintendent of the division and of the executive committee, such employé may be allowed in monthly payments an amount not exceeding twenty per cent of the regular salary pertaining to his position. In the case of an employé who has been more than fifteen years in the continuous service of the company, an additional three per cent may be allowed for each additional year of service up to twenty-five years, making the maximum allowance fifty per cent."

NEW INDEPENDENT TELEPHONE DEVELOPMENTS—A number of independent telephone companies have been for some time, it is announced, making provision for considerable development in several cities in Pennsylvania, New Jersey and Maryland. A new company to be known as the Interstate Telephone Company has completed arrangements, whereby it will control to a certain extent the independent companies of three states at least. The companies interested are the Atlantic Coast Telephone Company, the Keystone Telephone Company, of Philadelphia, the Pittsburg & Allegheny Company, of Pittsburg, and a number of smaller subsidiary companies that have established exchanges throughout New Jersey and Pennsylvania. It is the intention of the Interstate Telephone Company to begin construction of trunk lines connecting Millville, Vineland, Bridgeton, Ocean City, Tuckahoe, Cape May Court House, Mays Landing, Egg Harbor, and a number of smaller cities which have independent exchanges. It is also stated that within a short time trunk lines will be built to Philadelphia through Camden, and through that city will connect with Altoona, Baltimore, Pittsburg, Wheeling, Braddock and other points in western Pennsylvania, Ohio and West Virginia. Connection will be made with Richmond, and from that point other trunk lines will radiate to different points south and west. The parent company in New Jersey will be the Interstate Telephone Company. In Pennsylvania, in the western section, it will be the Pittsburg & Allegheny company. The parent company will transfer to the Atlantic Coast company a certain proportion of stock. The Atlantic Coast company will give in return an equivalent proportion of local stock. Similar arrangements will be made with the other companies.

LIGHTING AND TRACTION CONSOLIDATION—The United Gas Improvement Company, it is announced, has acquired interest in gas and electric companies in Delaware, Montgomery and Chester counties, Pennsylvania, and will merge all the companies under the name of the Merion & Radnor Gas and Electric Company, with a capital of $1,000,000. Samuel T. Bodine, second vice-president of the United Gas Improvement Company, is to be president of the new company, which is to be subsidiary to the present corporation. The necessary merger papers were filed in the state department at Harrisburg recently. The United Gas Improvement owns the gas and electric companies at Ardmore, Haverford, Bryn Mawr, Rosemont, Villanova, Wynnewood, Llanerich and Narberth. The other companies which are said to have been absorbed are the Lower Merion Gas Company, Wayne Electric Light Company, People's Gas Company, of Delaware County, Radnor Township Light Company, Radnor Township Heat Company, Eastown Township Light Company, Eastown Heat Company, and Upper Merion, Haverford Township, Newtown Township, Radnor Township, Eastown Township, Tredyffrin Township, and Willistown Township Electric Light companies. It is also stated that a deal of great import to the American Light and Traction Company, of Detroit, Mich., is pending, in which it is probable that the United Gas Improvement Company will take over the following companies included in the former corporation on a ninety-nine-year lease: Western Gas Company, of Milwaukee; St. Paul Gas Light Company, of St. Paul; Grand Rapids Gas Light Company, of Grand Rapids; St. Joseph Gas Company, of St. Joseph, Mo.; Madison Gas and Electric Company, of Madison, Wis.; Binghamton Gas Works Company, Binghamton, N. Y.; Southern Light and Traction Company, of San Antonio, Tex.; Consolidated Gas Company of New Jersey, of Long Branch, N. J. These are all in the group of McMillan companies, and the president of the American Light and Traction Company is Emerson McMillan, of New York.

ELECTRICAL SECURITIES.

Although the low level which has been reached in market values is in some instances considerably below that of 1901, when it was thought that the bottommost condition had been reached, the feeling which was existent at that time is nowhere evident just now. While securities are admittedly lacking in the apparent ability to recuperate, and the ruling prices have persistently declined, the lack of apprehension on the part of those whom a serious sag in values would injure to the greatest extent proves that the stability of the market, at least, is certain. The same element is still holding for a radical change of front in the condition of the market, and with the persistent declines, this element feels more surely the approaching of the turning point in market affairs.

The prolonged drought in the East and the extensive floods in the southern-central and western-central states have complicated crop predictions, and the labor troubles have also had an influence in shaping supply and demand. Notwithstanding these untoward factors, the continued note of prosperity which is very evident from every quarter is an assurance that it will take a greatly augmented list of catastrophes to bring about any serious economic depression.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JUNE 6.

New York:	*Closing.*
Brooklyn Rapid Transit	57½
Consolidated Gas	194
General Electric	177¼
Kings County Electric	200
Manhattan Elevated	136½
Metropolitan Street Railway	127½
New York & New Jersey Telephone	162
Westinghouse Manufacturing Company	196

The directors of the Commercial Cable Company have declared the regular quarterly dividend of 2 per cent, payable July 1. Books close June 20 and reopen July 2.

A dividend of $2 per share will be paid on July 15 to stockholders of the General Electric Company of record at the close of business on Saturday, June 20, 1903.

The Interborough directors have taken action on the Manhattan Elevated Railway dividend, payable July 1, and have authorized the declaration of a quarterly dividend of 1½ per cent, or at the rate of 6 per cent for the year, with an extra dividend of 1 per cent if earned at the end of the year. Books will close June 12.

The regular quarterly dividend of 1¾ per cent on the stock of the Metropolitan Street Railway Company is payable July 15. Books close June 24 and reopen July 16.

Boston:	*Closing.*
American Telephone and Telegraph	149½
Edison Electric Illuminating	225
Massachusetts Electric	82
New England Telephone	135
Western Telephone & Telegraph preferred	91

The stockholders of the Edison Electric Illuminating Company of Boston at a special meeting voted to increase the capitalization of the company from $8,635,500 to $9,499,100 by issuing 8,636 new shares of stock.

The gross earnings of the Boston Elevated Railway Company for May were almost $1,050,000, the largest in the history of the company.

Philadelphia:	*Closing.*
Electric Company of America	8½
Electric Storage Battery common	61
Electric Storage Battery preferred	61
Philadelphia Electric	6¼
Union Traction	46
United Gas Improvement	89¾

The directors of the Union Traction Company have declared a second semi-annual dividend of 1½ per cent. The terms of the lease by which the Philadelphia Rapid Transit Company absorbed the Union Traction Company last July were that for the first two years a dividend of 3 per cent was guaranteed; the next two, 4 per cent; the next two, 5 per cent, and 6 per cent thereafter for the remainder of the 999 years.

Chicago:	*Closing.*
Chicago Telephone	140
Chicago Edison Light	148
Metropolitan Elevated preferred	67
National Carbon common	24
National Carbon preferred	94
Union Traction common	4⅛
Union Traction preferred	30

South Side Elevated in May showed an average of 82,884 passengers daily, an increase of 9 per cent.

Metropolitan Elevated for May carried an average of 109,330 passengers daily, an increase of 3,531.

Northwestern Elevated Company's daily average of passengers was 66,990 for the month of May, an increase of 3,791.

PERSONAL MENTION.

MR. JACOB CLOOS, 1010 Pabst Building, Milwaukee, Wis., is the consulting engineer for the city council of Milwaukee. The council is considering the installation of a municipal electric light plant for street and commercial lighting, in conjunction with the new waterworks system.

MR. H. J. MINHINNICK, formerly electrical engineer for the Cedar Rapids & Marion Telephone Company, Cedar Rapids, Iowa, has been placed in charge of the new Chicago office which has been established by the New Haven Novelty Machine Company, of New Haven, Ct. Mr. Minhinnick is the western representative of the company.

MR. JOSEPH WETZLER, president of the Electrical Engineer Institute of Correspondence Instruction, New York city, is making a trip to Europe, where he intends to spend a vacation of several months in Continental travel with his family. Mr. Wetzler was formerly editor of the *Electrical Engineer*, and resigned this position to become president of the Correspondence Instruction School several years ago, where he has been remarkably successful.

MR. HAROLD McGILL DAVIS, advertising manager of the Sprague Electric Company, New York city, was married on Wednesday, June 3, to Miss Grace Inez Barrett. The wedding ceremony took place at the home of the bride's parents, at Saratoga, N. Y., the ceremony being performed by the Rev. Milton S. Littlefield, of New York. Mr. Davis and his wife will make an extended wedding trip, which will include visits to Lake George, Lake Champlain and Boston.

OBITUARY NOTICE.

MR. HENRY G. MORSE, president of the New York Shipbuilding Company, Camden, N. J., was stricken with apoplexy in New York city, at 2.30 Tuesday afternoon, June 2. Mr. Morse had entered the private office of Mr. J. P. Morgan, in Wall street, and while there was taken ill. He was removed to the Astor House, and was unconscious on reaching the hotel, dying fifteen minutes later. Mr. Morse was born in Poland, Ohio, April 10, 1850. He was graduated from the Rensselaer Polytechnic Institute, of Troy, in 1871, and became an engineer in the service of the Pennsylvania Railroad. In 1873 he became attached to the Wrought Iron Bridge Company, of Canton, Ohio, remaining with this company for five years. After this he was a partner in the Morse Bridge Company, of Youngstown, Ohio. After being for nine years president of the Edgemoor Bridge Works, of Wilmington, Del., Mr. Morse went into shipbuilding. He was president of the Harlan & Hollingsworth Company, of Wilmington, until 1898, when he began the organization of the New York Shipbuilding Company. Mr. Morse was prominent in New York city affairs, and was a member of many clubs, among them the Union League, the University Club, the Rensselaer Polytechnic Institute Alumni Association, the American Society of Civil Engineers, the Engineers' Club, and the American Institute of Mechanical Engineers.

NEW INCORPORATIONS.

READING, MICH.—The Camden Rural Telephone Company. $10,000.

DES MOINES, IOWA—The Ocheyedan Automatic Telephone Company. $6,000.

DETROIT, MICH.—Clark Electric Company. $25,000. Incorporators: William C. Clark, George E. Clark, James Clark and Gowan Clark.

ALBANY, N. Y.—The People's Illuminating Company. $25,000. Directors: C. C. Freeman and H. C. Eldert, of Brooklyn, and W. L. Freeman, of New York.

ALBANY, N. Y.—The Corporate Electric Company. $300,000. Directors: Harold S. Recknagel, Harold C. Vaughan and Walter L. Worrall, of New York, and C. C. Freeman and Henry C. Eldert, of Brooklyn.

ELECTRIC RAILWAYS.

MOLINE, ILL.—The directors of the Interurban road have decided to increase the capital stock from $125,000 to $200,000.

MALCOLM, NEB.—The Glen Oak & Prospect Heights street-car line has been sold to the Central City Company for $300,000.

LOS ANGELES, CAL.—It is asserted here that Senator W. A. Clark has purchased the traction company, the consideration being $450,000.

LOCKPORT, N. Y.—It is stated that the International Railway Company will build a large power-house in this city, work to commence at once.

WILKESBARRE, PA.—The Wilkesbarre & Wyoming Valley Traction Company will, it is stated, expend $200,000 on improvements during the coming year.

COLUMBUS, OHIO—The Dayton Southwestern Traction Company, of Dayton, has been incorporated with $10,000 capital, to build a line from Dayton to Camden.

NEW LEXINGTON, OHIO—The Perry Electric Company has been incorporated to build an electric railway from this city to Zanesville. The capital is $1,000,000.

UTICA, N. Y.—The last link in the through line of the Utica & Mohawk Electric Railroad between Rome and Little Falls, a distance of thirty-seven miles, has been opened.

SHEBOYGAN, WIS.—The Sheboygan-Elkhart Interurban Company has applied for an increase of its capital stock from $250,000 to $750,000. Grading has already been begun on the line.

CINCINNATI, OHIO—The directors of the Eastern Ohio Traction Company have decided to sell bonds to the amount of $500,000, the proceeds to be expended for extensions and improvements.

CAIRO, ILL.—The Cairo Electric and Traction Company has been organized with a capital of $150,000, and will take over the business of the two companies operating in that city at present.

SHARON, PA.—The East End Street Railway Company has been successfully financed, and the building of the road between here and West Middlesex is assured. The company is capitalized at $500,000.

ORION, ILL.—Promoters of the electric road to connect Kewanee, Cambridge and Geneseo, state that the road will be built this summer. It will serve a population of 40,000, and will cost $850,000.

COALPORT, PA.—The Northern Cambria Railway Company, with a capital of $126,000, will build a trolley line to connect Patton, Hastings, St. Boniface, Barnesboro, Spangler, St. Benedict, Bakerton and Carrolltown.

PLATTSVILLE, WIS.—The Iowa, Illinois & Wisconsin Interurban Railway Company has been organized with a capital of $750,000. The company will build an electric line from Dubuque to Plattsville, a distance of thirty miles.

MONTREAL, QUEBEC—The Ontario Electric Railway has practically decided to develop power by means of a dam at Glen Miller, on the Trent River, seven miles from Trenton. The installation at that point will cost $20,000.

ALBANY, N. Y.—The Lake Keuka & East Side Railroad Company has filed a certificate of incorporation with the Secretary of State. It plans to run an electric road from Penn Yan, Yates County, to Keuka, Steuben County. The capital is $130,000.

GLENS FALLS, N. Y.—It is announced that the Hudson Valley Railway Company has acquired the property and franchises of the North River Railway Company, which was organized to build an electric road from Saratoga to Glens Falls.

WINCHESTER, ILL.—At a special meeting of the city council a franchise was granted to the Jacksonville Traction Company, which will operate an electric line between Winchester and Jacksonville. The line must be in operation by January, 1905.

PITTSBURG, PA.—Surveys for the extension of the Kittanning & Ford City Street Railway Company's line from Wick Borough to Mossgrove, have been completed, and work will be pushed as rapidly as possible. The entire improvement will cost more than $100,000.

PHILADELPHIA, PA.—It is reported that the American Railways Company has purchased the entire capital stock and all the bonds of the Tyrone Electric Railway and Tyrone Electric Light and Heat Company, of Tyrone, Pa., $300,000 changing hands in the deal.

WESTFIELD, N. Y.—Willis H. Tennant, of Mayville, acting as attorney for the Westfield, Mayville & Chautauqua Motor Road Company, has petitioned the board of trustees of the village of Westfield for a franchise through the village for a term of 999 years.

MOUNT VERNON, N. Y.—The Interurban Railway Company, which includes the Union Railway, the New York, Westchester & Connecticut, and most of the trolley lines in Westchester County, will, it is stated, build a large power-house in this city, to cost about $60,000.

CINCINNATI, OHIO—Work has been begun at five different points on the line of the Cincinnati & Columbus Traction Company, and work has also been begun on the power-house in Cahoon. It is expected that cars will be in operation from Cincinnati to Hillsboro by November 1.

DIXON, ILL.—The Northern Illinois Electric Railway Company has let the contract for the construction of its road, and work will begin July 1. It is hoped to complete the portion to Amboy by January 1, 1904. Dixon and DeKalb are the termini of the road, which will be fifty-six miles in length.

OWENSBORO, KY.—Surveys are now being made for the proposed route of the Owensboro & Hartford Electric Railway Company, and it is expected that track laying will begin by August 1. The road will be fifty-five miles long. A large part of the capital to build the road will be furnished by local parties.

CINCINNATI, OHIO—The Cincinnati, Milford & Eastern Traction Company has let the contract for the construction of its road from Cincinnati to Blanchester, Ohio, and work has been begun. The contract calls for the completion of the road to Blanchester by November 1. The distance is thirty-one miles.

TRENTON, N. J.—The Easton & Washington Traction Company has filed articles in the office of the Secretary of State increasing the capital stock of the company to $1,250,000. The capital heretofore has been $100,000. The company will build a trolley line from Easton to Hackettstown and from Belvidere to Clinton, a system forty miles long, with Washington as the centre.

INDIANAPOLIS, IND.—The Chicago, Indiana & Michigan Traction Company, capital $500,000, has been incorporated by Hugh J. McGowan, president of the Indianapolis Street Railway Company, Edward L. McKee, John F. Wild, Lynn B. Martindale and Russell B. Harrison. The road is to run from Hammond through Michigan City, Porter, Valparaiso, and to South Bend.

CHARLESTON, W. VA.—A charter has been issued to the Fairmont & Clarksburg Traction Company, of Fairmont, W. Va., to construct a line from Burnsville, Marion County, to Clarksburg, W. Va. The company is capitalized at $2,000,000, and the incorporators are: S. L. Watson, L. L. Malone, C. Howell, Walton Miller, M. L. Hutchinson, of Fairmont, W. Va.

MOLINE, ILL.—The Illinois Union Traction Company has been incorporated with a capital of $500,000. The incorporators are: P. E. Elting, of Macomb; W. H. Beaver, of Abingdon; John W. Andrews, of New York, and W. W. McCullough, W. B. Young and S. S. Hallam, of Monmouth. With Monmouth as a centre, the lines will run north of Monmouth to Aledo, Moline, Rock Island and Muscatine, and south to Roseville, Macomb, Hamilton and Keokuk. A line will also run through Henderson County to a point on the Mississippi River, and from the north line a branch will be extended into Galesburg.

WALLINGFORD, CT.—The Wallingford Tramway Company, which was recently incorporated to build a street railway between this city and New Haven, has begun surveys. The road will connect with the Wallingford terminus of the Meriden Electric Company's system, and will run to Montowese, where it will join the Fairhaven and Westville Railroad companies' lines. The road will be the connecting link of a continuous trolley between Boston and New York. The work of construction will be undertaken this summer, and it is expected to have the road ready for operation by October. The company has a capital of $500,000, and the incorporators are all residents of Wallingford.

TELEPHONE AND TELEGRAPH.

COLUMBUS, OHIO—The Ney Telephone Company has been incorporated with a capital of $10,000.

HARWOOD, MO.—A rural long-distance telephone company has been organized here with a capital stock of $50,000.

MILWAUKEE, WIS.—The Wisconsin Telephone Company is planning to put in a new system at Elkhorn, at a cost of $5,000.

WALLACE, IDA.—The Rocky Mountain Bell Telephone Company will rebuild its line from here to Cœur d'Alene. The work will cost about $10,000.

OZARK, ALA.—Troy and Savannah, Ga., are to be connected by a telephone system, with stations at all intermediate points. Work has already been begun.

RAWLINS, WYO.—The telegraph line from here to Lander, recently purchased by the Bell Telephone Company, is to be converted into a telephone line.

COHOES, N. Y.—A local telephone company, capitalized at $50,000, has been organized at Clifton Park, and will be known as the Home Telephone Company.

RICHLAND CENTER, WIS.—The Union Telephone Company has passed into the hands of the Independent Consolidated Telephone Company, of Milwaukee.

ST. JOSEPH, MO.—Improvements aggregating nearly $75,000 will be made on the local plant of the Missouri & Kansas Telephone Company within the next few months.

DENISON, TEX.—The Tishomingo Telephone Company will at once extend its lines from Madill to Denison, and will also build a line from the Arkansas & Choctaw Railroad.

ATLANTA, GA.—The charter of the American Telephone and Telegraph Company has been approved. The company has a capital of $25,000 with the privilege of increasing to $500,000.

EVANSVILLE, IND.—The city council, by a unanimous vote, has passed the municipal telephone franchise. The company has almost $200,000 subscribed, and work on the plant will commence at once.

GLENWOOD, WIS.—The West Wisconsin Telephone Company, with headquarters at Glenwood, recently incorporated with a capital stock of $5,000, has its new lines in Boyceville completed and in operation.

MONTREAL, CANADA—The Merchants' Telephone Company has decided that as soon as necessary arrangements can be made, connections will be made throughout all the provinces of the Dominion.

INDEPENDENCE, MO.—Three telephone franchises have been granted by the city council, as follows: To the Kansas Home Company, the McDonald Company, and to a company represented by R. D. Mize.

ARMSTRONG, ME.—The Howard County Telephone Company is building a new line to connect Armstrong with Clifton Hill. The new line connects at Silver Creek with the Roanoke Mount Airy line.

PHILADELPHIA, PA.—The Independent Mutual Telephone Company, of Shenandoah, has given notice of an increase of capital stock from $50,000 to $100,000. The Dewitt Telephone Company has increased to $30,000.

CANANDAIGUA, N. Y.—Articles of incorporation have been filed by the Seneca-Gorham Telephone Company, with a capital of $6,000, to operate a telephone line in the eastern and southeastern part of Ontario County.

PITTSBURG, PA.—The Pittsburg & Allegheny Telephone Company will spend over $1,000,000 in perfecting a service to Philadelphia, Baltimore and other points. Its lines will follow the Pennsylvania Railroad.

HUTCHINSON, KAN.—The Missouri & Kansas Telephone Company is constructing a new line to Great Bend. In a short time the line will be extended to Larned, and later to Dodge City and other points to the west.

WOODSTOCK, VT.—The Rutland County Telephone Company has taken possession of the system, just completed, which embraces the towns of Wallingford, Tinmouth, Danby, Ira, Middletown, Springs Wells, Pawlet and Rupert.

CHATTANOOGA, TENN.—Local business men have organized the Hamilton Telephone and Power Company, and have applied for a charter giving them the right to construct and maintain a telephone system and electric light and power plants.

NEW YORK, N. Y.—At a meeting of the stockholders of the Cuyahoga Telephone Company it was voted to reduce the capital stock from $3,000,000 to $1,500,000. It was also decided to issue $1,500,000 six per cent cumulative preferred stock, and with the proceeds to make extensions and improvements in the service.

OLYMPIA, WASH.—The North American Telephone and Telegraph Company has been incorporated with a capital stock of $500,000, the principal office to be in Seattle. The incorporators are: Thomas Burke, John J. Healy, J. A. Ivy, O. D. Colin, Robert Moran, A. E. Lathrop, J. A. Moore and H. H. Noon.

TROY, N. Y.—At a meeting of the Franklin Telephone and Telegraph Company, operating lines in Saranac Lake, Lake Placid, Bloomingdale, Harriettstown, Saranac Inn and other places, it was voted to enter into arrangements with the Hudson River Telephone Company by which the Franklin Telephone Company buys the former's system at Lake Placid, and conducts a long-distance and local service from the same office.

BENNINGTON, VT.—The White Creek Telephone Company has been incorporated with a capital of $3,000, to construct a telephone line from Eagle Bridge, Rensselaer County, through White Creek, Washington County, to North Bennington and South Shaftsbury. The directors are S. E. Sweet, R. C. James, L. S. Sweet, Benedict W. Niles, Henry R. Perry, Steven B. Sweet, John C. Cottrell, George W. Sweet and John James, all of White Creek.

ELECTRIC LIGHTING.

WALDO, OHIO—An electric lighting plant is being installed in this village.

DETROIT, MICH.—The plant of the East Side Electric Company has been sold to Alexander Dow of the Detroit Edison Company, and two others, for a price said to be about $100,000.

MANSFIELD, MASS.—At a special town meeting it was voted to construct a municipal lighting plant. It was also voted to issue bonds to the amount of $40,000 to raise funds for this purpose.

BOZEMAN, MONT.—The announcement is made that the sale of the Gallatin Light and Power Company's plant has been consummated. The new company is composed of New York capitalists, and will at once take steps to enlarge and improve the plant.

LINCOLN, NEB.—The Interstate Electric Light and Power Company, of Butte, has filed articles of incorporation with the Secretary of State, with a capital of $40,000. The incorporators are: Charles A. Johnson and W. S. Pickler. The company will operate in Boyd and Holt counties, and in Gregory County, South Dakota.

SAN FRANCISCO, CAL.—Articles of incorporation of the Humboldt Power Company have been filed. The company has a capital of $500,000, and the directors are as follows: Charles P. Doe, of Alameda; Eugene Woodin, of Alameda; James Stanley, of Sausalito; C. Alvin Baird, of Eureka, and George L. Richardson, of San Rafael. The company will do an electric lighting and power business.

LAUREL SPRINGS, PA.—The Clementon Township Electric Improvement Company has been awarded a franchise to maintain an electric light plant at Laurel Springs, and to furnish light and power in the town of Magnolia, Stratford, Kirkwood, Lindenwold, Laurel Springs, Overbrook, Clementon and other points. The president of the new company is Jacob Ludy; vice-president, Henry V. Bassett; secretary, Joseph Borden; treasurer, Horatio E. Church. Work on the plant will be commenced at once.

BRAZIL, IND.—The Brazil Electric Company, which recently organized with $60,000 capital, has closed a deal for the purchase of the new Ball electric light plant in Brazil, and its ten-year lighting franchise with the city of Brazil. The Brazil Electric Company also secured from the board of county commissioners a franchise to construct a street car line from Brazil to Diamond, a distance of twelve miles, through Cardonia, Carbon, Pontiac and Perth. It is understood that eastern capital will be secured to build the line. The officers of the Brazil company are: President, Mayor Collins; vice-president, O. E. Adams; secretary and treasurer, H. D. Falls.

INDUSTRIAL ITEMS.

THE AMERICAN STOKER COMPANY has removed its general offices from New York city to Erie, Pa. All correspondence should, therefore, be addressed to the new headquarters.

THE CROCKER-WHEELER COMPANY, AMPERE, N. J., has issued a unique and handsome souvenir booklet entitled "The Source of the Electric Light." This shows a number of half-tone illustrations of Crocker-Wheeler generators in typical installations. The printing is well done, and the booklet is bound with a green cover with an embossed title in red.

THE SPRAGUE ELECTRIC COMPANY, New York city, has published a handsome catalogue descriptive of its Lundell fans for 1903. This describes and illustrates a line of famous models which have been popular for a number of years. The Sprague company will be pleased to send this catalogue on request.

THE COLONIAL ELECTRIC COMPANY, Ravenna, Ohio, will be pleased to send to any one interested its new catalogue descriptive of Colonial fans. The company is placing a strong line of direct-current desk and ceiling fans on the market, and the new catalogue describes these in detail, showing many half-tone illustrations.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., has recently sold a large number of telephones and supplies to the Farmers' Mutual Telephone Company, of Rinard, Ill; the Farmers' Mutual Telephone Company, of Richfield, Ill., and the Farmers' Mutual Telephone Company, of Virden, Ill.

THE AMERICAN AIR COMPRESSOR WORKS, 26 Cortlandt street, New York city, will be pleased to send on application its new catalogue "A," descriptive of American air compressors of every type for all pressures and for any purpose to which air is applied. This takes in carbonic acid gas compressors, air lift pumping systems, vacuum pumps, compressed air tools, and appliances of every description.

THE EWING-MERKLE ELECTRIC COMPANY conducted a formal opening of its new store, at 1106 Pine street, St. Louis, Mo., on Saturday, April 26. This company is making rapid strides in popularity, and is now presenting a strong line of electrical specialties to the trade. The company extends a cordial invitation to all the electrical people visiting St. Louis, to make their headquarters at the new offices of the company.

THE ALPHADUCT MANUFACTURING COMPANY, 522 West Twenty-second street, New York city, attracted a great deal of attention at the convention of the National Electric Light Association by its unique and practical souvenir in the form of a smoke pipe made from its fireproof conduit. This was most appropriate, and was greatly sought by members and visitors. Mr. William M. Porter is the western sales manager of the company, with headquarters at 303 Fisher Building, Chicago.

THE CONSOLIDATED ENGINE-STOP COMPANY, 100 Broadway, New York city, has printed a unique folder detailing a great amount of information with regard to the Monarch engine-stop and speed limit system, and the Monarch motor-stop. This includes a technical description of both of these apparatus, and a number of testimonials commendatory of these systems. As the folder is the result of a great deal of work and expense, the company will not make a promiscuous distribution of these, but will be pleased to send them to any authorized station manager or superintendent.

THE HOLTZER-CABOT ELECTRIC COMPANY, Boston (Brookline), Mass., is placing on the market a four-magnet bridging generator with self-contained cut-in springs. Other recent productions of the company are a battery telephone for use in hotels, schools, factories, etc., and a new short-lever hook, which is used on the battery telephones, and specially designed for use where little space is available. The company has recently issued a new catalogue descriptive of applications of Holtzer-Cabot motors. This is a noteworthy production, and will excite much interest among users of electric motors. The company will be pleased to send its descriptive literature on request.

THE H. W. JOHNS-MANVILLE COMPANY, New York city, made an elaborate and interesting exhibit of its well-known Sachs "Noark" enclosed fuse protective devices at its parlors in the Auditorium Hotel, during the convention of the National Electric Light Association. Particular interest was exhibited by those in attendance in the new large-capacity service switch and fuse boxes, which have recently been developed as large as 600 amperes; also single and double branch blocks, in three sizes, up to and including 100 amperes, two and three-poles. These are very compact in their construction. A line of high-potential strain insulators, guaranteed to stand 5,000 volts, and having a breaking strain of 6,000 pounds, was also shown. A number of orders have been taken for immediate delivery. A number of other specialties of the company's manufacture were exhibited, and examined by the visitors with considerable interest. J. W. Perry, manager of the electrical department from New York, was in attendance, and was assisted by S. H. Finney, manager of the electrical department of the Chicago office.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., manufacturer of the Strowger automatic telephone equipments, reports an increasing demand for automatic telephone apparatus. The company has recently sold to the Columbus Automatic Telephone Company, Columbus, Ga., a complete equipment for a present installation of 700 lines, the switchboard to have an ultimate capacity of 3,000 lines. The company has also secured the following orders: 100 station switchboard for the Mount Olive Telephone Company, Mount Olive, Ill.; 100 station switchboard for the Home Telephone Company, Birmingham, Ala., to be located in a branch exchange and work in connection with the larger exchange of that company in Birmingham; 100 station switchboard for the Vermillion County Telephone Company, Danville, Ill., to be located in a branch exchange and to be connected with the exchange in the city of Danville; 50 station switchboard for the United States Arsenal, Rock Island, Ill.; 40 station switchboard for the University of North Dakota, Grand Forks; 40 station switchboard for the Cape Railways Company, Cape Town, Africa; 150 station switchboard for A. J. Perkins & Son, Medford, Wis. The large exchange of 6,000 stations which the Automatic Electric Company is building for the Dayton Home Telephone Company, of Dayton, Ohio, is rapidly nearing completion, and it will only be a few weeks before the citizens of Dayton will have automatic telephone service.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., was very much in evidence at the convention of the National Electric Light Association, its exhibition features attracting a great deal of attention. The Auditorium Hotel Company has in use over 38,000 Sawyer-Man incandescent lamps. This company's generating room is located in the Annex of the hotel, and furnishes light and power for the two hotels and the theatre. It is the largest isolated plant in the West and includes a 500-kilowatt Westinghouse engine type direct-current generator. A special panel-board designed to show the operation of various types of Westinghouse precision instruments was also to be seen in the dynamo room. A brief explanation of the operation and construction of these instruments is worthy of note. (1) The synchroscope—The angle between the instruments being synchronized is always equal to the angle between the pointer and the vertical position. When the movable pointer coincides with the dummy pointer at the top of the scale, the machines are in phase and the switch may be closed, thus synchronizing the machines in the shortest possible time, and with the least possible current flowing between them at the moment of closing the switch. (2) Power-factor meter—Indicates power-factor of circuits directly, for either a leading or lagging current, and also indicates, on lower half of dial, when power is being delivered in reverse direction. Used with generators it shows whether or not each machine is working proportionately; with rotary converters it serves as an indicator by which to adjust the field current for minimum armature current. (3) Type F wattmeter—Indicates true energy, whatever the power-factor of the circuit may be. Is perfectly dead-beat. Long scale, same as ammeter and voltmeter. (4) Type F ammeter—Perfectly dead-beat, very desirable where current fluctuates. (5) Type F voltmeter—Uniform and proportional. As with other type F meters, these are induction instruments, closely allied to integrating wattmeters. (6) Two-wire, single-phase, integrating wattmeter—Induction type, requires no electrical connections to the moving parts. (7) Frequency meter—Can be calibrated for any cycle range. Accurately, dead-beat, large open scale. Meter consists of two voltmeter magnets, which tend to rotate the shaft carrying the pointer in opposite directions, the shaft taking the position when the torques are equal. Any change in the frequency of the circuit brings shaft, as well as pointer, to the new position.